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# SOIL SURVEY

## Wilbarger County, Texas



UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Conservation Service

in cooperation with

TEXAS AGRICULTURAL EXPERIMENT STATION

## HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Wilbarger County will serve several groups of readers. It will help farmers and ranchers in planning the kind of management that protects their soils and provides good yields and will assist engineers in selecting sites for roads, buildings, and other structures. It provides general information about this part of Texas and adds to our fund of knowledge about soils.

Soil scientists studied and described the soils and made a map that shows the kind of soil everywhere in the county. The base for the soil map is a set of aerial photographs that show roads, buildings, streams, and many other landmarks.

### Locating the soils

Use the index to map sheets to locate areas on the large map. The index is a small map of the county that shows the location of each sheet of the large map. When the correct sheet of the large map is found, it will be seen that the boundaries of the soils are outlined in red and that there is a red symbol for each soil, wherever it is shown on the map. Suppose, for example, an area located on the map has the symbol AbA. The legend for the detailed map shows that this symbol stands for Abilene clay loam, 0 to 1 percent slopes. This soil and all others mapped in Wilbarger County are described in the section "Descriptions of the Soils."

### Finding information

This report has several sections for different groups of readers. The section "Additional Facts About the County," which gives some information about the settlement, industries, climate, and agriculture, will be of interest mainly to those who are not familiar with the county.

*Farmers and ranchers and those who work with them* can learn about the soils in the section "Descriptions of the Soils" and then turn to the section "Use and Management of the Soils." In this way, they can first identify the soils on their farms or ranches and then learn about the suitability of these soils for agriculture and the methods of maintaining productivity. The soils are grouped by capability units; that is, groups of soils that need similar management and respond in about the same way. For example, Abilene clay loam, 0 to 1 percent slopes, is in capability unit IIc-1 and in the Deep Hardland range site. Some suggestions on the management needed for this soil will be found under the heading "Capability unit IIc-1" in the section "Use and Management of the Soils." Some additional information will be found in the subsection "Management of the Soils for Range."

The "Guide to Mapping Units," which is just before the map sheets, will simplify the use of the map and the report. The guide lists the symbol for each soil, the name of the soil, and the page on which the soil is described; the symbol for the capability unit in which the soil is placed and the page on which the capability unit is described; and the name of the range site in which the soil is placed and the page on which the range site is described.

*Those who need only general information about the soils* can refer to the section "General Soil Map." This section tells briefly about the principal patterns of the soils, where they are located, and how they differ from each other.

*People interested in soil science* will find information about how the soils were formed and how they are classified in the section "Formation and Classification of the Soils."

*Engineers and builders* will find information that will assist them in building and maintaining roads and other structures in the section "Engineering Properties of the Soils."

Cover picture: Aerial view of terracing, contour farming, and strip cropping in Wilbarger County, Texas.

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# SOIL SURVEY OF WILBARGER COUNTY, TEXAS

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE  
TEXAS AGRICULTURAL EXPERIMENT STATION

WILBARGER COUNTY is in north-central Texas. It is bordered on the west by Hardeman County and Foard County, on the south by Baylor County, and on the east by Wichita County. The Red River forms the northern boundary (fig. 1).

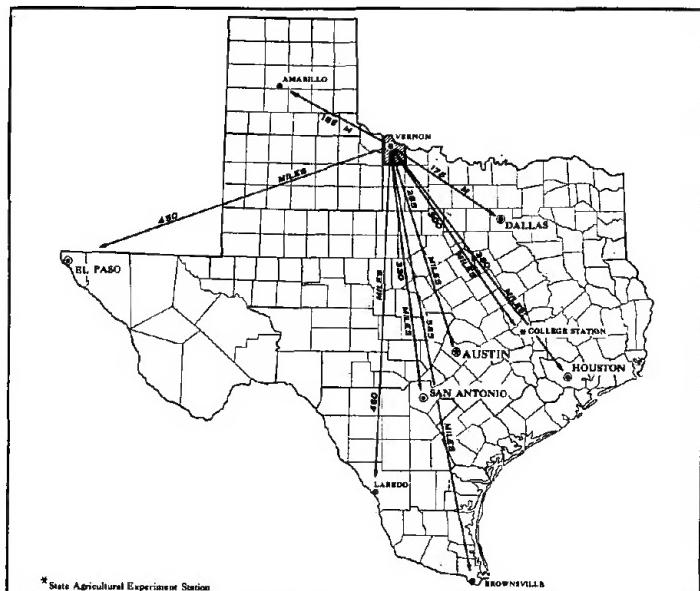


Figure 1.—Location of Wilbarger County in Texas.

Vernon, the county seat, is 48 miles northwest of Wichita Falls in Wichita County. In 1960, the population of Vernon was 12,141. The town serves a productive livestock, farming, and oil-producing area.

Wilbarger County has a total area of 615,680 acres. About 45 percent of the county is cropland, much of which is subject to both wind and water erosion. Like most other central and western Texas counties, the county has periods of drought, some of which last for 1 or 2 years. About 55 percent of the county is rangeland.

Farmers and ranchers in the county organized the Wilbarger-Wichita Soil Conservation District in 1945. It comprises Wilbarger County, Wichita County, and parts of Archer, Baylor, and Knox Counties. Through this district the farmers and ranchers receive technical assistance from the Soil Conservation Service in planning for the use and conservation of the soils on their farms and ranches. This soil survey was made as a part of that

technical assistance. Fieldwork for the survey was completed in 1959. Unless otherwise indicated, all statements in this report refer to conditions in the county at the time the fieldwork was in progress.

## *How Soils are Named, Mapped, and Classified*

Soil scientists made this survey to learn what kinds of soils are in Wilbarger County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Abilene and Wichita, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in natural characteristics.

Many soil series contain soils that are alike except for texture of their surface layer. Separations called soil types are made according to this difference in texture. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Wichita clay loam and Wichita loam are two soil types in the Wichita series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting

their use that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Enterprise very fine sandy loam, 3 to 5 percent slopes, is one of several phases of Enterprise very fine sandy loam, a soil type that ranges from nearly level to rolling.

Because of extreme shallowness or poor drainage, a few soils in the county do not have all the characteristics of any of the defined series. They are given the name of the series that they most closely resemble and are called variants. Cobb fine sandy loam, shallow variant, and Altus fine sandy loam, poorly drained variant, are examples.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photographs for their base map because they show woodlands, buildings, field borders, trees, and similar detail that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, a soil scientist has a problem of delineating areas where different kinds of soils are so intricately mixed, or that are so small in size, that it is not practical to show them separately on the map. Therefore, he shows this mixture of soils as one mapping unit and calls it a soil complex. Ordinarily, a soil complex is named for the major soil series in it, for example, Abilene-slickspot complex and Vernon complex. Also, in most mapping, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Rough broken land, clayey, or Sandy alluvial land, and are called land types rather than soils.

Only part of the soil survey was done when the soil scientist had named and described the soil series and mapping units and had shown the location of the mapping units on the soil map. The mass of detailed information he had recorded then needed to be presented in different ways for different groups of users, among them farmers, managers of rangelands, and engineers.

To do this efficiently, he had to consult with persons in other fields of work and jointly with them prepare groupings that would be of practical value to different users. Such groupings are the capability classes, subclasses, and units, designed primarily for those interested in producing short-lived crops and tame pasture; range sites, for those using large tracts of native grass; and the classifications used by engineers who build highways or structures to conserve soil and water.

## General Soil Map

After a study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report, which shows the six soil associations in Wilbarger County. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic although not strictly uniform.

The soils within any one association are likely to differ greatly among themselves in some properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general map does not show the kind of soil at any particular place, but a pattern that has in it several kinds of different soils.

The soil associations are named for the major soil series in them, but, as already noted, soils of other associations may also be present. The major series of one soil association may also be present in other associations but in a different pattern.

The general map showing patterns of soils is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

In general, the soils in Wilbarger County form three broad landscapes: Soils formed in old water-laid material, known as outwash; soils formed in residuum of Permian red-bed materials; and soils on the bottom lands, which formed in recent alluvium.

## Soils in Outwash

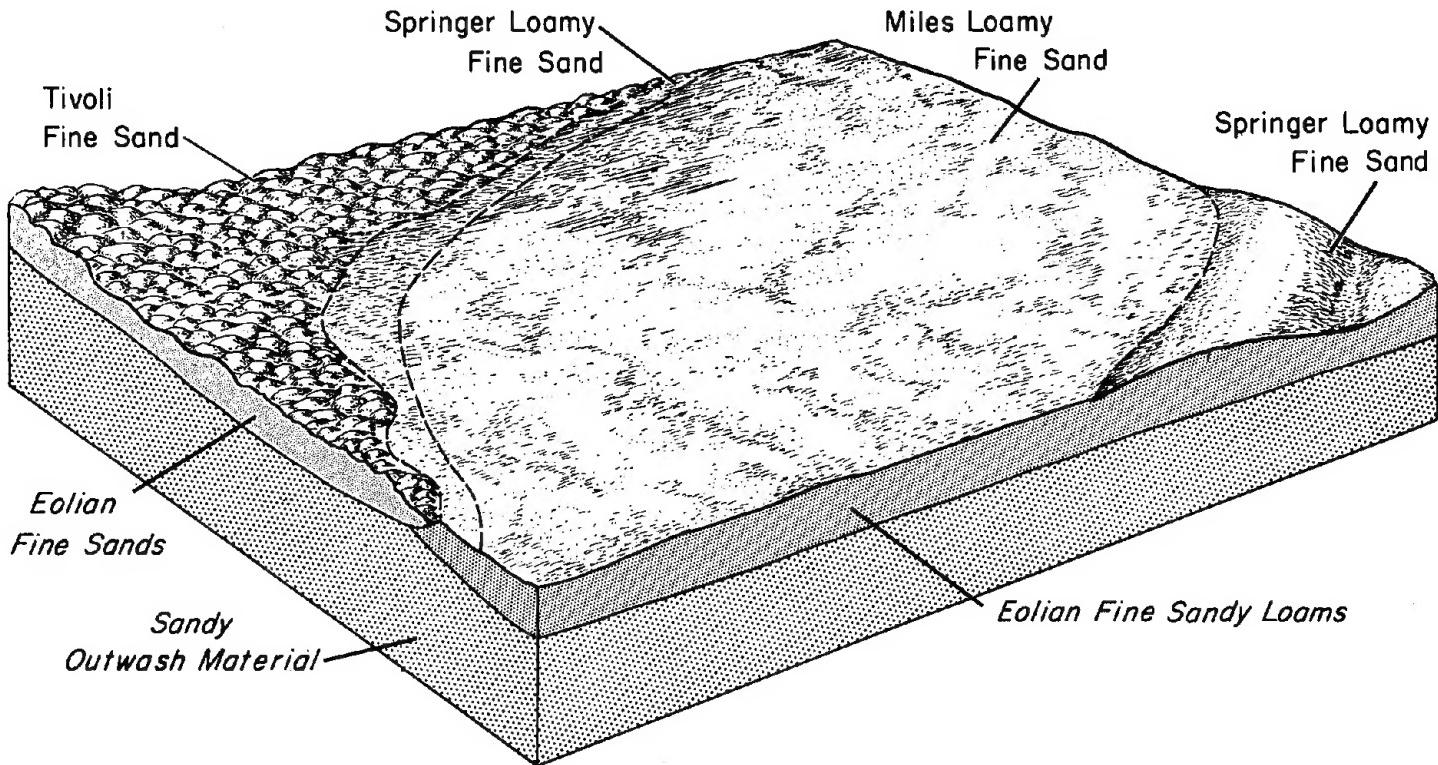
Soils that developed in outwash are the principal soils of the northern two-thirds of Wilbarger County. This outwash, also known as plains outwash, was deposited in the form of terraces and upland interstream deposits by streams flowing from the mountains of New Mexico and Trans-Pecos, Texas (7).<sup>1</sup> It forms a thick mantle that rests unconformably on the Permian red beds (5). It consists chiefly of sands, sandy clays, and some gravel and is a part of the Seymour formation of Quaternary (Pleistocene) age. Deposition, however, probably began late in the Pliocene epoch. The Seymour formation is the principal water-bearing formation in the county and is the source of much of the water used for irrigation. Part of this water-laid material has been reworked by wind during Recent time, or since the Pleistocene epoch.

### *1. Abilene-Hollister association (level hardland)*

The soils in this association form a nearly level to very gently sloping plain. The soils are dark colored and moderately fine textured. Abilene clay loam makes up about 70 percent of the association; Hollister clay loam, about 10 percent; and Vernon complex, about 10 percent. The remaining 10 percent consists of Miles, Wichita, Vernon, and Tillman soils. Hollister, Tillman, and Vernon soils formed in red-bed materials, which crop out in places throughout this part of the county.

About 18 percent of the county is in this association. A little more than three-fourths of the acreage is cultivated,

<sup>1</sup> Italic numbers in parentheses refer to Literature Cited, p. 63.



**Figure 2.**—Block diagram showing the geographical association of the soils in association 2. Here, the soils formed in a mantle of windblown sand, which lies over sandy outwash material.

chiefly to wheat and cotton. For the most part, there are few conservation problems other than maintenance of soil fertility and storage of the limited amount of rainfall. The more sloping soils adjacent to drains and on the intervening ridges are susceptible to water erosion.

### **2. Miles-Springer association (sandy soils)**

The soils in this association form a gently sloping, billowy to hummocky, sandy plain in the northern and western parts of the county. Smoother, more nearly level areas, 100 acres or more in size, are common throughout the plain. In the northern part of the county, these soils constitute the major part of the gently rolling section known as the Odell Sand Hills.

Miles loamy fine sand constitutes about 50 percent of the association; Springer loamy fine sand, about 40 percent; and Tivoli fine sand, about 10 percent (fig. 2). Miles loamy fine sand has a sandy clay loam subsoil, whereas Springer loamy fine sand has a fine sandy loam subsoil. These soils are highly susceptible to wind erosion, and their fertility is low.

About 17 percent of the county is in this association. Three-fourths of the acreage is cultivated, chiefly to cotton and grain sorghum. Alfalfa is also grown, dry farmed, on a large acreage, since most of this area has a high water table.

### **3. Miles-Enterprise association (moderately sandy soils)**

The moderately sandy soils in this association are nearly level to gently sloping. Miles fine sandy loam makes up

about 65 percent of the acreage; Enterprise fine sandy loam, about 15 percent; Cobb fine sandy loam, about 15 percent; and Enterprise very fine sandy loam, about 5 percent. The subsoil of Miles and Cobb soils is sandy clay loam, and that of Enterprise soils is fine sandy loam.

These soils are moderately susceptible to wind erosion and slightly to moderately susceptible to water erosion. They are moderately fertile, but plant nutrients are soon leached from the surface soil.

This association makes up about 8 percent of the county. Most of the acreage is cultivated. The soils are among the better soils in the county for cotton and wheat. A large acreage is planted to alfalfa because of the relatively high water table that underlies most of this area. Grain sorghum is becoming an important cash crop.

### **4. Enterprise-Tipton association (mixed land)**

This association consists of nearly level to gently sloping, very friable, loamy soils. They occur on the low terraces along the Pease and Red Rivers (fig. 3).

Enterprise very fine sandy loam makes up about 55 percent of the association, and Tipton silt loam, about 45 percent. Tipton silt loam is not so red as the Enterprise soils and has a more clayey subsoil. These soils are among the most productive in the county. Other than maintenance of fertility and good tilth, they present no serious conservation problems.

About 5 percent of the county is in this association. Almost 95 percent of the acreage is cultivated, chiefly to cotton, wheat, and alfalfa. Yields of all the general crops are high in years of adequate rainfall.

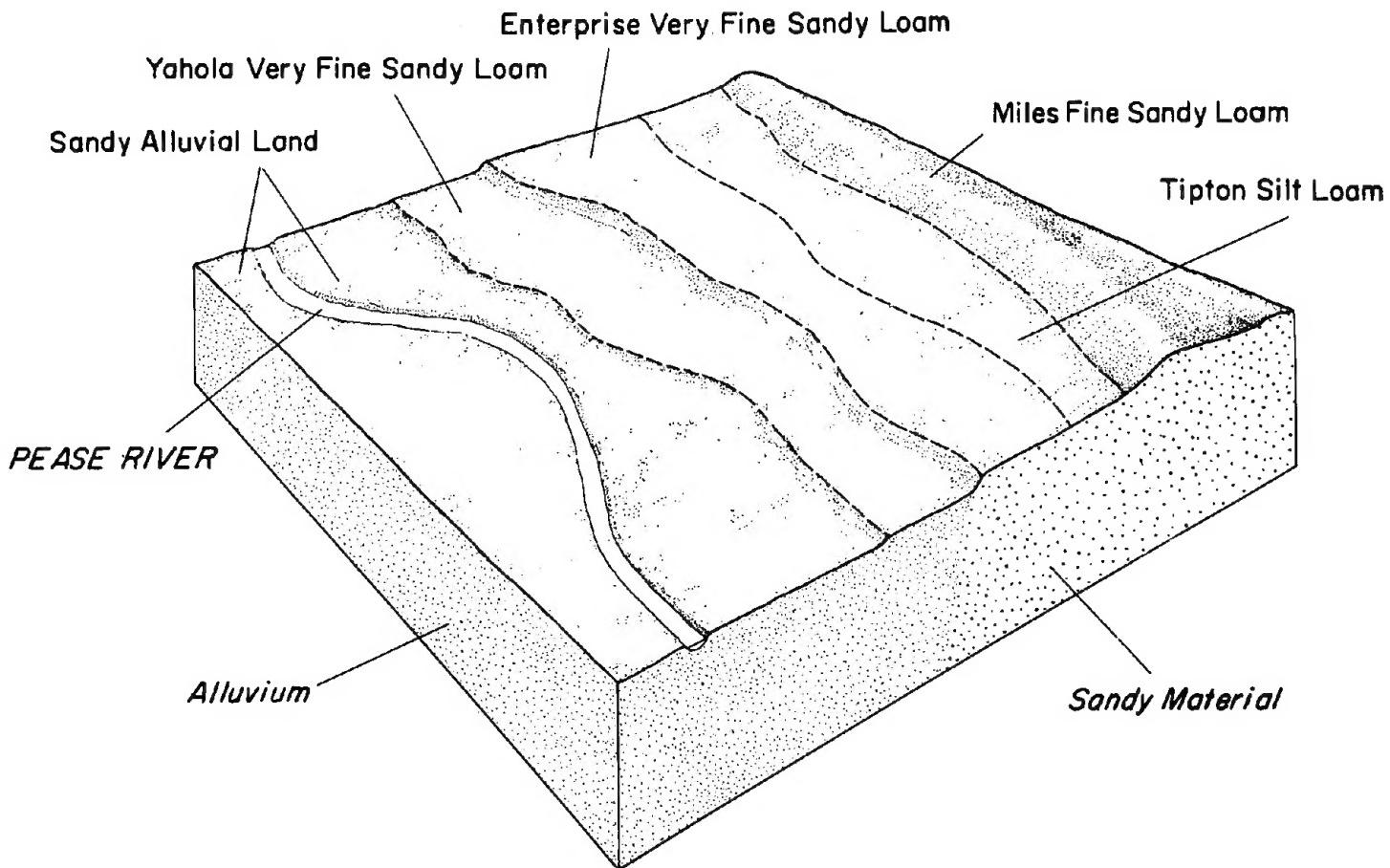


Figure 3.—Block diagram showing the geographical association of the soils on the low terraces along the Pease River. Sandy alluvial land and Yahola very fine sandy loam, which formed in recent alluvium, are in soil association 6. Miles fine sandy loam, which is in soil association 3; Enterprise very fine sandy loam; and Tipton silt loam formed in sandy outwash that has been reworked by wind in some places.

## Soils in Red Beds

Permian red-bed deposits crop out in various places throughout Wilbarger County and constitute most of the surface formations in the southern part.

### 5. *Tillman-Vernon association (hardland)*

This soil association makes up almost 48 percent of the county. The soils are reddish brown, gently sloping to steeply sloping, and moderately fine textured. They developed in the clays and shales of the Permian red beds. About 40 percent of the association is Tillman clay loam; 35 percent, Vernon soils; 10 percent, Rough broken land, clayey; and 15 percent, soils in the Norwood, Hollister, and Wichita series.

Tillman soils are the deep, well-developed soils on the smooth flats and divides (fig. 4). They are somewhat droughty, have a slow rate of infiltration, and are susceptible to water erosion. The shallow, weakly developed Vernon soils occupy the more sloping areas along drains. They are too shallow and droughty for most cultivated crops and are highly susceptible to water erosion.

The arable soils in this association are best suited to small grains and sorghums for forage.

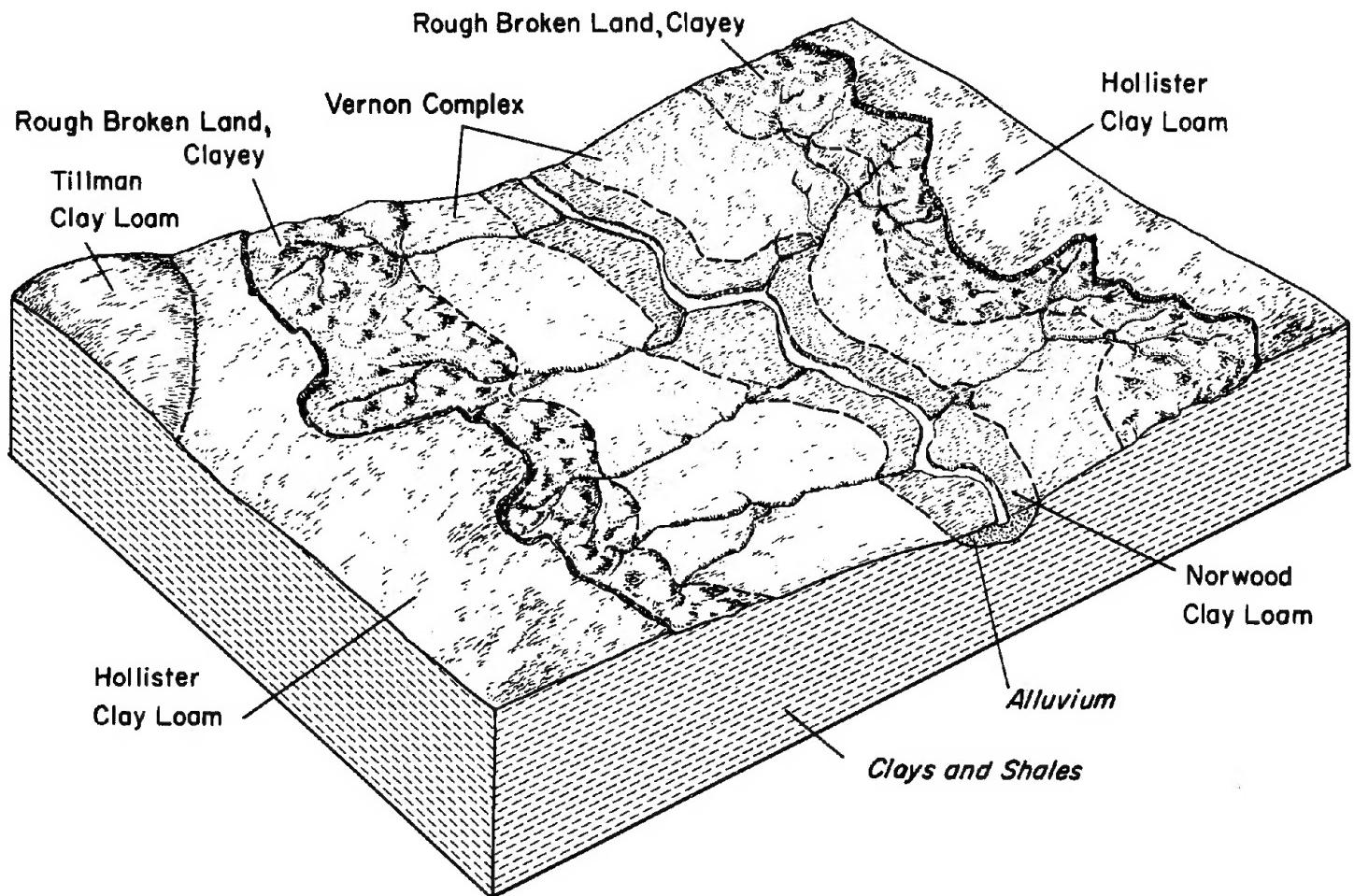
## Soils in Recent Alluvium

Recent alluvial deposits of material washed from the surrounding uplands occur along the major streams and most of the intermittent drains in the county.

### 6. *Lincoln-Yahola association (bottom land)*

This association consists of soils on the wide, nearly level flood plains of the Pease and Red Rivers. It makes up about 4 percent of the county. About 40 percent of the association is Lincoln loamy fine sand; 17 percent, Yahola very fine sandy loam; and 43 percent, Sandy alluvial land. The geographical association of these soils is shown in figure 3, which also shows the soils on the low terraces of the Pease River.

About a third of the acreage in this association is cultivated, chiefly to cotton, wheat, and alfalfa. Yahola very fine sandy loam is a productive soil well suited to most of the general crops. Lincoln loamy fine sand is much less productive and is highly susceptible to wind erosion. Large areas of this soil were formerly cultivated, but most of them have been abandoned because of the soil's low fertility and its susceptibility to blowing.



**Figure 4.**—Block diagram showing the geographical association of some of the soils developed in clays and shales. Norwood clay loam, which formed in recent alluvium, is in soil association 6.

## Descriptions of the Soils

This section gives detailed information about the soils of Wilbarger County. It describes the soil series, or groups of similar soils, and the individual mapping units. The descriptions are arranged in alphabetical order, by series.

An important part of the description of each soil series is a detailed description of the soil profile. The profile described for each series is "typical"; that is, it represents the most common condition of each property of the soils in the series. All the soils of any one series have essentially the same profile. The differences, if any, are explained in the description of each soil in the series or are evident in the name of the soil.

In these descriptions, some technical terms and special methods of recording information are used, simply because there seems to be no other practical way to report accurately and briefly what readers need to know about soils. Most of these terms are defined in the Glossary at the back of this report.

The letters *A*, *B*, and *C* are used to designate horizons in the soil profile. Each letter conveys a special meaning, as is explained in the Glossary. *A* indicates the top layer

or layers, to a depth of 6 to 14 or 16 inches; the letter *B*, subsoil layers; and *C*, the parent material from which the *A* and *B* layers were formed. These horizons can be divided, for example *A*<sub>1</sub>, and *A*<sub>2</sub>, or *B*<sub>1</sub>, *B*<sub>2</sub>, and *B*<sub>3</sub>.

The thickness of the soil layers varies from place to place. Hence, in the profile given for each series, the thickness in inches given at the beginning of the description of each layer is the thickness at the location sampled. The range of thickness for this layer, considering the many other profiles of soils in the series that were examined, is given in the variations that follow the description of the profile.

The boundaries between horizons are described to indicate their thickness. The terms for thickness are (1) *abrupt*, if less than 1 inch thick; (2) *clear*, if about 1 to 2½ inches thick; (3) *gradual*, if 2½ to 5 inches thick; and (4) *diffuse*, if more than 5 inches thick.

The color of the different soil layers is given in words and Munsell notations; for example, "dark brown (7.5 YR 4/2)." The Munsell notations describe color more precisely than can be done in words; they are useful when it is necessary to make close comparisons among soils. In this report, colors are given for the soil when dry and when moist; if the description of color is not

followed by "when moist," the color is for dry soil. Color is usually a good indicator of the amount of organic matter in the soil. As a rule, the darker the surface soil, the more organic matter it contains. Streaks and spots of gray and yellow in the lower subsoil generally indicate poor drainage.

*Texture*, or the relative proportion of sand, silt, and clay in the soil, is determined in the field by the way the soil feels when it is rubbed between the fingers. This is later checked by laboratory analysis.

*Structure* refers to the aggregation of soil particles into compound particles, or clusters of primary particles. The strength of the aggregates is indicated by *weak, moderate, or strong*; their size, by *very fine or very thin, fine or thin, medium, coarse or thick*, and *very coarse or very thick*; and their shape, by *granular, platy, prismatic, columnar, crumb, subangular blocky, blocky*, and *irregular blocky*. Soils without definite structure are described as *structureless*; they are either *single grain* (sands) or *massive* (clays).

*Consistence* is the property of the soil aggregates that resists crushing or change of shape. It is described for the soil when wet as *plastic or sticky*; for the soil when moist as *loose, very friable, friable, firm, very firm*, and *extremely firm*; and for the soil when dry as *loose, soft, slightly hard, hard, very hard*, and *extremely hard*.

Other characteristics observed in the course of the field study and considered in classifying the soils include the depth of the soil to bedrock or other underlying material, the presence of gravel or stones, wetness, salinity, reaction,

the steepness and pattern of soil slopes, and the degree of erosion by wind and water.

The location and distribution of the soils in Wilbarger County are shown on the map at the back of this report. Within each of the mapping units are small inclusions of other soils, usually less than 5 acres in size, that are too small to be shown on the map or to have any particular significance in the management of the soil.

The approximate area and proportionate extent of the soils are given in table 1. River channels are listed near the end of this table. These consist of dry, loose sand beds and channels that are flooded several times a year and are dry the rest of the time. There is no vegetation, and the sand is shifted by water and wind into complex, billowy patterns. They have no agricultural value.

### Abilene Series

Soils in this series are deep, dark colored, well developed, and friable. The parent material consists of highly calcareous, moderately fine textured, old water-laid deposits, commonly known as plains outwash. The range plants now growing on these soils are buffalograss, blue grama, side-oats grama, mesquite trees, pricklypear, and lotebush.

The surface layer is brown to very dark grayish brown and is moderately fine textured (fig. 5). It is very friable when moist and has granular structure. The subsoil has a similar color but a more clayey texture. The upper part of the subsoil is friable when moist; it grades to a less friable and more clayey lower layer. Beneath this layer

TABLE 1.—*Approximate area and proportionate extent of the soils*

Soil	Area	Extent	Soil	Area	Extent
Abilene clay loam, 0 to 1 percent slopes-----	59,010	9.6	Miles loamy fine sand, 0 to 3 percent slopes-----	38,290	6.2
Abilene clay loam, 1 to 3 percent slopes-----	16,840	2.7	Miles loamy fine sand, 3 to 5 percent slopes-----	550	.1
Abilene-slickspot complex-----	480	.1	Miller clay-----	2,780	.4
Altus fine sandy loam-----	1,140	.2	Miller clay loam-----	6,600	1.1
Altus fine sandy loam, poorly drained variant-----	610	.1	Norwood clay loam-----	15,660	2.5
Altus loamy fine sand-----	1,470	.2	Norwood silt loam-----	1,330	.2
Cobb fine sandy loam, 1 to 3 percent slopes-----	960	.2	Oil-waste land-----	1,030	.2
Cobb fine sandy loam, shallow variant-----	2,430	.4	Port clay loam-----	2,220	.4
Enterprise fine sandy loam, 0 to 1 percent slopes-----	2,330	.4	Rough broken land, clayey-----	37,330	6.1
Enterprise fine sandy loam, 1 to 3 percent slopes-----	4,380	.7	Rough broken land, loamy-----	2,790	.4
Enterprise very fine sandy loam, 0 to 1 percent slopes-----	7,340	1.2	Sandy alluvial land-----	9,970	1.6
Enterprise very fine sandy loam, 1 to 3 percent slopes-----	8,750	1.4	Springer loamy fine sand, hummocky-----	7,920	1.3
Enterprise very fine sandy loam, 3 to 5 percent slopes-----	1,630	.3	Springer loamy fine sand, undulating-----	29,420	4.8
Enterprise very fine sandy loam, 5 to 8 percent slopes-----	830	.1	Tillman clay loam, 0 to 1 percent slopes-----	20,000	3.2
Hollister clay loam, 0 to 1 percent slopes-----	4,090	.7	Tillman clay loam, 1 to 3 percent slopes-----	78,220	12.7
Hollister clay loam, 1 to 3 percent slopes-----	1,490	.2	Tillman clay loam, 1 to 3 percent slopes, eroded-----	570	.1
Lincoln loamy fine sand-----	9,330	1.5	Tipton silt loam, 0 to 1 percent slopes-----	7,950	1.3
Loamy alluvial land-----	31,770	5.2	Tipton silt loam, 1 to 3 percent slopes-----	2,610	.4
Mansker loam, 1 to 3 percent slopes-----	2,020	.3	Tivoli fine sand-----	12,850	2.1
Mansker loam, 3 to 5 percent slopes-----	1,330	.2	Vernon clay loam, 2 to 5 percent slopes-----	44,390	7.2
Mansker loam, 5 to 8 percent slopes-----	780	.1	Vernon complex-----	38,750	6.3
Miles fine sandy loam, 0 to 1 percent slopes-----	29,940	4.9	Wichita clay loam, 0 to 1 percent slopes-----	1,780	.3
Miles fine sandy loam, 1 to 3 percent slopes-----	25,330	4.1	Wichita clay loam, 1 to 3 percent slopes-----	23,110	3.8
Miles fine sandy loam, 3 to 5 percent slopes-----	1,710	.3	Wichita loam, 0 to 1 percent slopes-----	1,580	.3
Miles fine sandy loam, 2 to 5 percent slopes, eroded-----	850	.1	Yahola very fine sandy loam-----	3,830	.6
Miles fine sandy loam, 5 to 8 percent slopes-----	340	.1	Gravel pits-----	130	(1)
			Artificial lakes-----	2,020	.3
			River channels-----	4,820	.8
			Total-----	615,680	100.0

<sup>1</sup> Less than 0.1 percent.

is a strongly calcareous layer, the  $B_{ca}$  horizon, that contains accumulated carbonates.

Abilene soils have a less clayey, more friable subsoil than Hollister soils, with which they are associated. They are more clayey than the reddish Miles soils and less calcareous than the reddish-brown Vernon soils. They are similar to Wichita soils but are grayish brown rather than reddish brown.

In Wilbarger County, three-fourths of the acreage of Abilene soils is on old terrace flats or in broad, weakly concave valleys. The broad flats, which are as much as 8,000 acres in size, are interrupted only by sloping, shallow to deep drains. Along the shallow drains, calcium salts and sodium salts from seepage water commonly occur on the surface.

Abilene soils are among the better soils for wheat in the county. They are well suited to cotton, but yields are lower than on the less clayey soils. Local farmers report that crops grown on these soils show little response to fertilizer.

**Profile of Abilene clay loam in a site reached by going 2.7 miles north from the Vernon courthouse on U.S. Highway 283, 0.6 mile west and 0.4 mile north on farm road 925, and 0.3 mile north on rural road:**

- A<sub>p</sub> 0 to 6 inches, dark-brown (7.5YR 4/2, 3/2 when moist) clay loam; weak to moderate granular structure; slightly hard when dry, very friable when moist; noncalcareous; a little waterworn gravel scattered over surface; abrupt boundary.
- B<sub>1</sub> 6 to 15 inches, dark-brown (7.5YR 4/2, 3/2 when moist) silty clay loam; weak subangular blocky and granular structure; hard when dry, friable when moist; noncalcareous; many very fine pores and few fine pores; few medium worm casts; clear boundary.
- B<sub>2</sub> 15 to 27 inches, dark-brown (7.5YR 4/2, 3/2 when moist) heavy silty clay loam or light clay; moderate, blocky and subangular blocky structure; very hard when dry, firm when moist; noncalcareous; common very fine pores and few fine pores; few worm casts; clear boundary.
- B<sub>ca</sub> 27 to 62 inches, brown (7.5YR 5/2) heavy silty clay loam, dark brown (7.5YR 4/2) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; strongly calcareous; common, fine, hard concretions of calcium carbonate and few, coarse, soft concretions; common very fine pores; few ferromanganese concretions; gradual boundary.
- C<sub>ca</sub> 62 to 96 inches +, light-red (2.5YR 6/6) light clay, red (2.5YR 5/6) when moist; firm when moist; very strongly calcareous; many coarse, soft lumps and much soft, segregated calcium carbonate; few pockets of red-bed clay and gypsum in lower part of the horizon.

**Variations.**—The A horizon is from 6 to 10 inches thick. Although this horizon is dominantly noncalcareous, a few reddish-brown, weakly calcareous spots, a few feet in diameter, are present on the surface. The friable B<sub>1</sub> horizon is 7 to 12 inches thick. The B<sub>2</sub> horizon is 8 to 24 inches thick; its structure is mostly moderate, medium, blocky, but it ranges from moderate, fine, subangular blocky to moderate, medium, blocky and irregular blocky. The A, B<sub>1</sub>, and B<sub>2</sub> horizons range from brown to very dark grayish brown, hue 7.5YR to 10YR. The depth to the B<sub>ca</sub> horizon ranges from 20 to 42 inches. Concretions of calcium carbonate make up 3 to 6 percent of the soil mass in this layer. The depth to the C<sub>ca</sub> horizon ranges from 40 to 72 inches. Calcium carbonate makes up 10 to 40 percent of this horizon.

**Abilene clay loam, 0 to 1 percent slopes (AbA).**—This soil makes up nearly 10 percent of the total land area in the county. It is nearly level and easily tilled, and water



**Figure 5.—Profile of Abilene clay loam.** The A horizon is 6 inches thick; the B<sub>1</sub> horizon extends from 6 to 14 inches; the B<sub>2</sub> horizon, from 14 to 34 inches; and the B<sub>ca</sub> horizon, from 34 to 54 inches.

erosion is not a problem. It is considered the most productive soil for wheat in the county. Except in areas not easily reached, most of it is cultivated.

Included with this soil are Abilene clay loam, 1 to 3 percent slopes, which occurs on small ridges and in narrow bands along shallow drains and constitutes about 4 percent of the mapping unit; small circular areas of Wichita clay loam, about 2 percent; and a few small areas of Abilene sandy clay loam and Abilene silt loam. These inclusions are suited to the same crops and are about as productive as Abilene clay loam, 0 to 1 percent slopes. (Capability unit IIc-1, dry-farmed; I-2, irrigated; Deep Hardland range site)

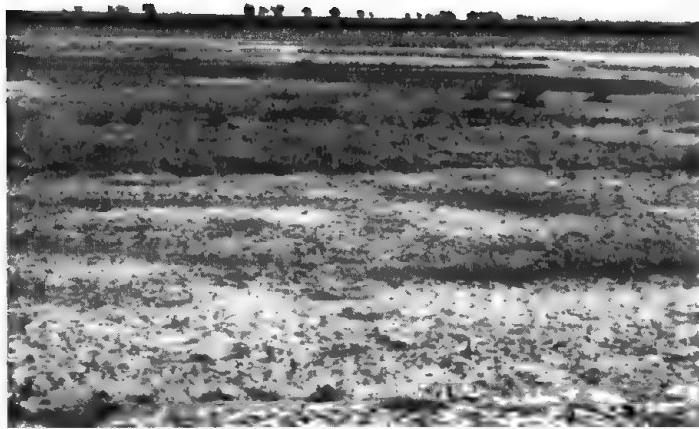


Figure 6.—Representative area of Abilene-slickspot complex. White areas are salty slickspots.

**Abilene clay loam, 1 to 3 percent slopes (AbB).**—This soil is more shallow and has a lighter colored B horizon than the soil described as representative of the Abilene series. It occurs in two distinct positions in the county—in narrow, gently sloping, concave bands along shallow drains that carry runoff from higher lying areas, and on gently sloping, convex ridges, irregular in shape and about 200 acres in size. The average slope is 1.6 percent.

A few gullies, 4 to 10 inches deep and 2 to 15 feet wide, have been cut on some of the side slopes of the drains in cultivated areas. These gullies can be smoothed over, and further cutting can be controlled if a terrace system is installed and conservation farming is practiced. In a few areas, the surface soil has been thinned a few inches by sheet erosion.

Included in this mapping unit are narrow bands and small oblong areas of Abilene clay loam, 0 to 1 percent slopes, which make up about 2 percent of the mapping unit; inextensive ridges of Wichita clay loam; and narrow bands of Vernon clay loam. (Capability unit IIe-1, dry-farmed; Deep Hardland range site)

**Abilene-slickspot complex (Ak).**—This complex is about 55 percent Abilene clay loam and about 45 percent slickspots. A thin gray crust forms on the surface of the Abilene soil in this complex when it is dry. Otherwise it resembles the Abilene soils previously described.

The slickspots, also known as alkali spots, occur either as narrow strips or as circular spots scattered throughout areas of Abilene clay loam (fig. 6). To a depth of 4 to 7 inches, the surface layer of these slickspots is light brownish-gray clay loam that has granular structure and puddles easily. When the puddled areas dry out, they get a hard surface crust that is difficult to break. The subsoil, to a depth of 18 to 26 inches, is grayish-brown, calcareous clay that is very hard when dry and very sticky when wet. Nodules of salts and lime occur throughout this layer, which is underlain by a strongly calcareous horizon that contains accumulated carbonates and extends to a depth of 45 to 65 inches. Like the Abilene soils, slickspots formed in calcareous, clayey, old water-laid deposits.

This nearly level to gently sloping complex occurs along shallow drains. Most areas are less than 50 acres in size,

but some are as much as 90 acres. Inclusions of Altus fine sandy loam, poorly drained variant, constitute about 12 percent of the mapping unit.

Most of the acreage is cultivated. Moderate yields of small grains and cotton are obtained on the Abilene soil in years of adequate rainfall. Some slickspots have such a high content of salts that most crops cannot be grown. Low yields of small grains, however, can be obtained in years of adequate rainfall. (Capability unit IIIIs-1, dry-farmed; Deep Hardland range site)

### Altus Series

Soils in the Altus series are deep, brown to dark brown, and moderately coarse textured to coarse textured. The parent material consists of calcareous, moderately sandy, old water-laid deposits known as plains outwash.

The surface layer is brown to dark brown and very friable when moist. The subsoil is brown to dark grayish-brown, friable sandy clay loam. It is underlain by less dark colored, highly calcareous material. Water accumulates on these soils during periods of high rainfall, but it is absorbed rapidly and stored.

Altus soils are not extensive in Wilbarger County, where they occur in broad, concave upland flats that look like beds of ancient lakes. They are closely related to Miles and Springer soils, which formed in the same kind of parent material. Altus soils are darker colored and have a more clayey subsoil than Miles soils, which occupy higher lying ridges and plains. They are darker colored and less sandy than Springer soils, which occur on higher ridges and knolls.

Altus soils are among the most productive in the county. Excellent yields of dry-farmed cotton and alfalfa are obtained.

Profile of Altus loamy fine sand in a site reached by going 1 mile east of Odell on farm road 91 and then 1.4 miles south on rural road:

- A<sub>1</sub> 0 to 10 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) when moist; structureless or weak granular structure; loose when dry, very friable when moist; noncalcareous; abrupt boundary.
- B<sub>1</sub> 10 to 18 inches, dark-brown (7.5YR 4/3) fine sandy loam; compound structure—weak prismatic and weak subangular blocky; slightly hard when dry, very friable when moist; noncalcareous; very fine and fine pores common; gradual boundary.
- B<sub>2</sub> 18 to 30 inches, grayish-brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) when moist; compound structure—weak prismatic and weak subangular blocky; very hard when dry, friable when moist; noncalcareous; many very fine pores and common fine pores; few worm casts; gradual boundary.
- B<sub>3</sub> 30 to 41 inches, grayish-brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) when moist; compound structure—weak prismatic and weak subangular blocky; very hard when dry, friable when moist; strongly calcareous; gradual boundary.
- C<sub>1</sub> 41 to 60 inches, light-gray (10YR 7/2) fine sandy loam, light brownish gray (10YR 6/2) when moist; hard when dry, very friable when moist; very strongly calcareous; few, fine, soft concretions of calcium carbonate.

**Variations.**—The thickness of the A horizon ranges from 6 to 20 inches; the texture, from fine sandy loam to loamy fine sand; and the color, from brown to dark brown, hue 7.5YR to 10YR. The B horizon ranges in thickness from 24 inches or less to 45 inches, in texture from fine sandy loam in the upper part to light sandy clay in the lower part, and in color

from dark brown to dark grayish brown, hue 7.5YR to 10YR. In some places, the Altus soils are underlain, at a depth of 40 inches, by a noncalcareous, dark-brown soil.

**Altus loamy fine sand (As).**—This soil is the sandiest of the Altus soils. It occurs in slightly depressed areas, 50 to 125 acres in size. The average slope is 0.5 percent.

The dark color of the surface layer and the subsoil indicates a high content of organic matter. This soil is not so susceptible to wind erosion as the sandy soils in the Miles and Springer series. Most areas show little evidence of wind erosion. In a few spots on the rims of the depressions, the surface layer has been winnowed.

This soil is considered the most productive sandy soil in the county. Practically all the acreage is cultivated, chiefly to cotton, alfalfa, and grain sorghum.

Narrow bands or knolls of Miles loamy fine sand and Springer loamy fine sand, which occur along the rims of the depressions, are included in this mapping unit. A few small, circular spots of Altus fine sandy loam, which occurs in the lowest part of the depressions, are also included. These inclusions make up less than 5 percent of the total acreage. (Capability unit IIIe-7, dry-farmed; Sandy Land range site)

**Altus fine sandy loam (Am).**—The surface layer of this soil is 6 to 12 inches thick. In a few places, it is weakly calcareous. Otherwise, the soil resembles the soil described as representative of the Altus series. It is sandier than, but otherwise similar to, Tipton soils.

This soil is nearly level and shows little evidence of wind erosion. It is easily tilled and worked into a seed-bed. Except for a few isolated areas that remain in range, all the soil is cultivated. It is suited to all the crops grown in the county.

Narrow bands of Altus loamy fine sand, Miles loamy fine sand, and Miles fine sandy loam are included. Altus loam and Altus clay loam make up about 10 percent of the acreage. (Capability unit IIe-3, dry-farmed; IIe-1, irrigated; Mixed Land range site)

**Altus fine sandy loam, poorly drained variant (Ap).**—This soil is similar to Altus fine sandy loam in the dark-colored surface layer and upper part of the subsoil. At a depth of 3 to 4 feet, however, free water, which has seeped horizontally through sandy layers of higher lying Miles and Springer soils, has accumulated in the lower subsoil and substratum. Some of this water, which is high in soluble salts, rises to the surface and evaporates. The salts are left in a white crystalline form on the surface of the soil. These salty spots make up about 12 percent of the mapping unit.

Moderate yields of small grains are obtained on most areas of this soil. Few crops can be produced on the salty areas, however, except in years of adequate rainfall. Several formerly cultivated areas have been returned to grass, chiefly bermudagrass. (Capability unit IIIw-1, dry-farmed; Mixed Land range site)

## Cobb Series

This series consists of reddish-brown, shallow to moderately deep soils that formed in reddish-brown to gray, fine-grained sandy residuum of Permian sandstone. The range plants now growing on these soils are side-oats

grama, blue grama, sand dropseed, three-awn, and buffalograss.

The reddish-brown surface layer is very friable. The subsoil is reddish-brown sandy clay loam that has subangular blocky structure. It is hard when dry and friable when moist.

Cobb soils are associated with Miles soils and the sandier Springer soils, both of which developed in sandy "outwash," or old alluvium. Cobb soils are less calcareous and more red than Mansker soils and more friable and less clayey than Vernon soils.

In Wilbarger County, Cobb soils occur mostly on a gently rolling, high ridge in the northwestern part. They also occur on small ridges and in narrow bands along drains throughout the southeastern part of the county.

These soils are droughty and low in natural fertility. Cultivated areas are used mostly for oats and other feed crops or for supplemental grazing.

Profile of Cobb fine sandy loam in a site reached by going 1.1 miles southeast from the Hardeman County line on U.S. Highway 287, then 0.65 mile south, 0.15 mile east, and 0.6 mile southwest:

- A<sub>1</sub> 0 to 6 inches, reddish-brown (5YR 5/4, 4/4 when moist) fine sandy loam; weak subangular blocky and granular structure; hard when dry, very friable when moist; noncalcareous; abrupt boundary.
- B<sub>1</sub> 6 to 12 inches, reddish-brown (2.5YR 4/3) sandy clay loam, dark reddish brown (2.5YR 3/3) when moist; compound structure—weak prismatic and moderate medium subangular blocky; hard when dry, friable when moist; noncalcareous; faint patchy clay films; many very fine pores and few fine pores; common worm casts; clear boundary.
- B<sub>2</sub> 12 to 22 inches, reddish-brown (2.5YR 4/4) sandy clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate to strong, medium, subangular blocky structure; very hard when dry, friable when moist; noncalcareous; distinct patchy clay films; many very fine pores and few fine pores; common worm casts; clear boundary.
- B<sub>3</sub> 22 to 37 inches, reddish-brown (2.5YR 4/5) sandy clay loam, dark reddish brown (2.5YR 3/5) when moist; moderate, medium, subangular blocky structure; very hard when dry, friable when moist; noncalcareous; many very fine pores and common fine pores; few worm casts; few fine and medium sandstone fragments; gradual boundary.
- C 37 to 42 inches, red (10R 4/6) light sandy clay loam, dark red (10R 3/6) when moist; partially weathered, noncalcareous, red, gray, and olive sandstone; few concretions of iron and manganese; abrupt boundary.
- D<sub>1</sub> 42 to 45 inches +, semi-indurated to soft sandstone.

**Variations.**—The A horizon is reddish brown to brown, hue 5YR to 7.5YR. The B horizon ranges from 14 to 30 inches in thickness, from light to heavy sandy clay loam in texture, and from red to reddish brown, hue 2.5YR to 5YR. Depth to the C horizon is from 22 to 45 inches. In a few places, the C horizon contains a weak zone of accumulated calcium carbonate.

**Cobb fine sandy loam, 1 to 3 percent slopes (CoB).**—This moderately deep soil occupies gently sloping ridges that have an average gradient of 1.4 percent. Most areas are irregular in shape and from 15 to 150 acres in size.

This soil is moderately susceptible to both wind erosion and water erosion. In a few places, the wind has winnowed the surface layer and left lenses of sandy loam. In places where the slope approaches 2 percent, runoff has cut a few gullies, 8 to 12 inches deep and 20 to 50 inches wide. These can be smoothed over within a few years if

conservation farming is practiced and a terrace system is installed.

This soil is best suited to crops that have a short growing season. It is more productive, more fertile, and less droughty than Cobb fine sandy loam, shallow variant. Yields of cotton and wheat, however, are lower than those produced on Miles fine sandy loam. Most areas are cultivated.

Included are a few nearly level areas of Cobb fine sandy loam and also some small areas of Cobb fine sandy loam, shallow variant. These inclusions make up less than 5 percent of the total acreage. (Capability unit IIIe-3, dry-farmed; Mixed Land range site)

**Cobb fine sandy loam, shallow variant (Cs).**—This soil is similar in most characteristics to the soil described as representative of the Cobb series. The solum, however, is thinner by 15 to 21 inches and lacks a  $B_3$  horizon. Most areas are gently to moderately sloping, convex ridges and knobs, 8 to 30 acres in size.

Unprotected cultivated areas are subject to water erosion. The easily detached, fine-grained sandy material erodes readily during pounding rains. A few gullies, 6 to 8 inches deep and 30 to 60 inches wide, have been cut on the steeper slopes where runoff concentrates. These can be partially erased within a few years if a terrace system is installed and conservation farming is practiced. In a few places, wind has winnowed the surface soil and left lenses of sandy loam.

Included in the mapping unit are some narrow bands and pockets of Cobb fine sandy loam, 1 to 3 percent slopes, which make up about 5 percent of the total acreage, and some small areas of Miles fine sandy loam. (Capability unit IVe-6, dry-farmed; Mixed Land range site)

## Enterprise Series

The Enterprise series consists of reddish-brown to brown, very friable, calcareous, youthful soils. They formed in wind-laid very fine sands and silts blown from the channels of rivers that drain the plains of western Oklahoma and Texas. The range plants now growing are little bluestem, sand bluestem, sand dropseed, side-oats grama, and other grasses.

Water readily infiltrates the very friable, thick surface layer, which has granular structure. The subsoil is yellowish-red very fine sandy loam. It has prismatic structure and is very friable when moist.

In Wilbarger County, these soils occupy gently rolling to nearly level, low terraces along the Pease and Red Rivers. They are associated with Tipton, Springer, and Tivoli soils. They lack the developed  $B$  horizon of Tipton soils and are lighter colored. They are less red and less sandy than Springer soils. They are not so sandy as Tivoli soils.

Soils in the Enterprise series are productive and are considered very desirable soils, even for dryfarming. Crops grown on them respond well to fertilizer. They are moderately susceptible to water erosion.

Profile of Enterprise very fine sandy loam in a cultivated field reached by going 0.1 mile west from Doans, then 0.95 mile north, and 200 feet east:

$A_{1p}$  0 to 6 inches, brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 4/4) when moist; weak granular structure; soft when dry, very friable and

crumbly when moist; weakly calcareous; abrupt boundary.

$A_{2p}$  6 to 22 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) when moist; compound structure—weak prismatic and weak granular; slightly hard when dry, very friable and crumbly when moist; weakly calcareous; many fine pores; many worm casts and channels; gradual boundary.

AC 22 to 68 inches, yellowish-red (5YR 5/6, 4/6 when moist) very fine sandy loam; compound structure—weak coarse prismatic and weak granular; slightly hard when dry, very friable when moist; strongly calcareous; common threads and films of calcium carbonate; gradual boundary.

C 68 to 80 inches +, yellowish-red (5YR 5/8, 4/8 when moist) very fine sandy loam; slightly hard when dry, very friable when moist; strongly calcareous; common threads and films of calcium carbonate.

*Variations.*—The A horizon is from 12 to 24 inches thick. In a few places, the  $A_1$  layer is noncalcareous. The color of both the A and AC horizons ranges from yellowish red to brown, hue 5YR to 7.5YR. In about half the profiles examined, there are layers of accumulated calcium carbonate. In about 10 percent of the acreage, there is a buried, dark-brown soil horizon at a depth of 50 inches.

**Enterprise very fine sandy loam, 0 to 1 percent slopes (EnA).**—This soil is not so red as the soil described as representative of the series, and it contains a higher proportion of silt. It constitutes about 15 percent of the total acreage of Enterprise soils in the county. It occurs in oblong, nearly level to very slightly sloping areas that are as much as 175 acres in size. The slightly sloping areas are weakly concave and have a gradient of 0.8 percent.

This highly productive soil is easily tilled and worked into a good seedbed. If it is plowed and cultivated to the same depth each time, however, a plowpan is soon formed. Water erosion is not a hazard.

Most of the acreage is cultivated. Some of the highest cotton yields in the county and excellent yields of most of the general crops are obtained on this soil.

Inclusions consist of some of the other Enterprise soils, which make up about 2 percent of the acreage. About 10 percent of the acreage has a silt loam surface soil. (Capability unit I-1, dry-farmed; I-1, irrigated; Mixed Land range site)

**Enterprise very fine sandy loam, 1 to 3 percent slopes (EnB).**—This is the most extensive of the Enterprise soils in the county. Areas mapped are from twenty to several hundred acres in size. The gently rolling, convex slopes have an average gradient of 1.6 percent and range up to 3,000 feet in length.

Above-average yields of most of the general crops are obtained on this soil, which is easily tilled and worked into a good seedbed. Unprotected fields, however, are subject to water erosion. Gullies, 12 to 16 inches deep and 20 to 50 inches wide, have been formed in a few places. The surface soil has been thinned, and, along the rims of the deeper gullies, a few rills have been cut. Terrace systems and contour farming will help to prevent the formation of more gullies.

Included are some narrow bands and ridges of other Enterprise soils, totaling about 4 percent of the acreage. About 6 percent of this soil has a silt loam surface layer. (Capability unit IIe-2, dry-farmed; Mixed Land range site)

**Enterprise very fine sandy loam, 3 to 5 percent slopes (EnC).**—The A horizon of this soil is thinner and redder than the A horizon of the soil described as representative of the series. This soil occurs in narrow bands and on high ridges, oblong and elliptical in shape, within larger areas of less sloping Enterprise soils. Slopes are convex and seldom more than 800 feet long. The average gradient is 4 percent.

Like all Enterprise soils, this soil is easily tilled and worked into a good seedbed. Except for areas not easily reached, the acreage is cultivated. A few gullies, 14 to 20 inches wide and 30 to 60 inches deep, have been cut where water has concentrated on unprotected fields. The surface soil has been thinned, and some rills have been formed. These gullies and rills can be partially obliterated if a terrace system is installed and conservation farming is practiced.

A few narrow bands of less sloping Enterprise soils along foot slopes and on ridgetops are included in this mapping unit. These inclusions amount to about 4 percent of the total acreage. (Capability unit IIe-2, dry-farmed; Mixed Land range site)

**Enterprise very fine sandy loam, 5 to 8 percent slopes (EnD).**—This soil is more friable and lighter colored than the soil described as representative of the series. It occupies convex slopes adjacent to escarpments and to gullies that drain higher lying soils. These slopes have an average gradient of 7 percent and are as much as 600 feet long.

Much of the acreage of this soil remains in range. Several deep gullies have been cut on unprotected cultivated areas by runoff from higher land.

Small areas of other Enterprise soils make up 6 percent of the acreage. (Capability unit IVe-2, dry-farmed; Mixed Land range site)

**Enterprise fine sandy loam, 0 to 1 percent slopes (EfA).**—This soil is thinner, more sandy, and less fertile than any of the Enterprise very fine sandy loams. It is easily tilled and worked into a good seedbed. Most of the rainfall is readily absorbed; any that runs off collects in lower lying concave areas and is quickly absorbed there. In a few cultivated areas, wind has winnowed the plow layer and left lenses of loamy fine sand.

Except for a few areas not easily reached, this soil is cultivated. Moderate yields of most of the general crops are obtained.

Small knolls of other Enterprise soils, amounting to about 3 percent of the total acreage, are included. (Capability unit IIe-4, dry-farmed; IIe-2, irrigated; Mixed Land range site)

**Enterprise fine sandy loam, 1 to 3 percent slopes (EfB).**—This soil occurs in irregular patterns along ridges and knolls. Slopes are convex and have an average gradient of 1.8 percent. In a few cultivated areas, wind has winnowed the plow layer and left lenses of loamy fine sand. On some of the more steeply sloping areas, concentrated runoff has cut a few shallow gullies. Much of this erosion can be prevented by providing a cover of either crops or crop residues during the critical erosion period. Moderate yields of most of the general crops can be obtained on this soil in years of adequate rainfall.

Included are some small areas of Enterprise fine sandy loam, 0 to 1 percent slopes, and narrow bands of Tipton

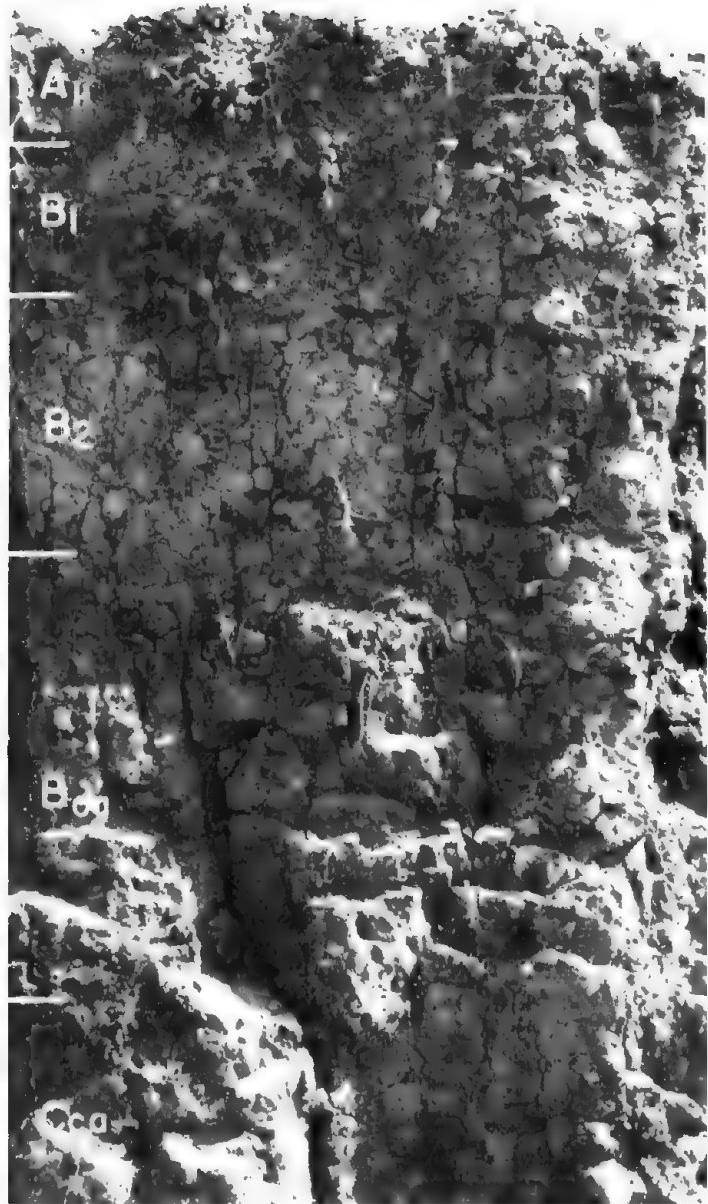


Figure 7.—Profile of Hollister clay loam. The A horizon is 6 inches thick; the B<sub>1</sub> horizon extends from 6 to 12 inches; the B<sub>2</sub> horizon, from 12 to 22 inches; and the B<sub>ca</sub> horizon, from 22 to 46 inches.

silt loam and Miles fine sandy loam. These inclusions are suited to the same crops as this soil. (Capability unit IIIe-4, dry-farmed; IIIe-1, irrigated; Mixed Land range site)

### Hollister Series

This series consists of well-developed, nearly level to gently sloping, deep soils that formed in Permian clays and shales. The range plants now growing on these soils are blue grama, side-oats grama, buffalograss, and threeawn, scattered mesquite trees, and pricklypear.

The noncalcareous, brown to dark grayish-brown surface soil has very fine subangular blocky structure (fig. 7). It is slightly hard when dry and very friable when

moist. The upper part of the subsoil is a little more clayey than the surface soil. The lower part of the subsoil is dark-brown, blocky clay that is very hard and compact when dry, is very firm when moist, and contains nodules of lime. The subsoil is underlain by a highly calcareous, clayey layer containing accumulated calcium carbonate.

Hollister soils are associated with Abilene soils and the higher lying Tillman soils. They have a thicker and more distinct  $B_1$  horizon than the reddish-brown Tillman soils, which also developed in Permian clays and shales. They are more clayey and have a firmer and less calcareous lower subsoil than Abilene soils, which formed in plains outwash.

Soils in the Hollister series are not extensive in Wilbarger County. About three-fourths of the acreage consists of nearly level plains or flats that are interrupted only by abrupt escarpments. Soils in the Vernon complex and Rough broken land, clayey, occupy these escarpments, which parallel drains and tributaries.

Soils in the Hollister series are fertile, but they are droughty because of the heavy clay subsoil. Moderate yields of small grains are obtained in years of adequate rainfall, but yields ordinarily are lower than on the associated Abilene soils. Local farmers report that crops grown on Hollister soils do not respond to fertilizer.

Profile of Hollister clay loam in a site reached by going 1.7 miles west from the Vernon courthouse and 3.4 miles northwest on U.S. Highway 287, then 2.5 miles west on farm road 925, and 1.3 miles north on rural road:

- A<sub>p</sub> 0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; weak subangular blocky structure; hard when dry, friable when moist; noncalcareous; abrupt boundary.
- B<sub>1</sub> 6 to 12 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark brown (10YR 2/2) when moist; weak subangular blocky structure; hard when dry, friable when moist; noncalcareous; fine pores common; thin patchy clay films; clear boundary.
- B<sub>2</sub> 12 to 22 inches, dark-brown (7.5YR 4/2, 3/2 when moist) clay; moderate, fine to medium, irregular blocky structure; very hard when dry, firm when moist; noncalcareous; few very fine pores; distinct patchy clay films; clear boundary.
- B<sub>ca</sub> 22 to 46 inches, dark-brown (7.5YR 4/2, 3/2 when moist) light clay; moderate, fine to medium, irregular blocky structure; very hard when dry, firm when moist; strongly calcareous; common, fine to coarse, hard concretions of calcium carbonate; few, coarse, soft spots of calcium carbonate between peds; few, medium, reddish-brown spots; distinct patchy clay films; gradual boundary.
- C<sub>ca</sub> 46 to 62 inches, reddish-brown (5YR 5/4, 4/4 when moist) light clay; very hard when dry, firm when moist; strongly calcareous; common, fine to coarse, hard and soft concretions of calcium carbonate; few concretions of iron and manganese; gradual boundary.
- C 62 to 68 inches +, partially weathered, calcareous, clayey red-bed material; few pockets of gypsum crystals.

**Variations.**—The hue of the 4- to 6-inch, noncalcareous A horizon is from 7.5YR to 10YR. The B horizon is from 16 to 28 inches thick and from 7.5YR to 10YR in hue. The structure of the upper part of the B horizon ordinarily is subangular blocky, but, in the lower part, the range is from moderate, medium, blocky to moderate, medium, irregular blocky. Depth to the B<sub>ca</sub> horizon ranges from 22 to 38 inches. The layer containing accumulated calcium carbonate ordinarily is thin, but the range is from 10 to 22 inches. Throughout the area of Hollister soils there are some spots, 15 to 30 feet in diameter, in which the surface soil is very dark grayish brown. In some of these places, reddish-brown calcareous spots occur

next to the darker colored areas; these areas form a very complex color pattern when the soil is freshly plowed.

**Hollister clay loam, 0 to 1 percent slopes (HcA).**—This soil makes up about three-fourths of the total acreage of Hollister soils in the county. The long, weakly convex slopes have an average gradient of 0.6 percent.

This soil is easily tilled and is not especially subject to water erosion. It is too droughty for adequate yields of cotton, however, and cultivated areas are cropped principally to winter wheat.

Included in this mapping unit are Tillman clay loam, which occurs along the rims of the broad flats of Hollister clay loam and makes up 2 percent of the acreage; Foard clay loam, which is not mapped separately in the county and constitutes about 4 percent; Abilene clay loam, which occupies weakly concave areas above drains and makes up about 3 percent; and Hollister clay loam, 1 to 3 percent slopes, which makes up about 2 percent. (Capability unit IIc-1, dry-farmed; I-2, irrigated; Deep Hardland range site)

**Hollister clay loam, 1 to 3 percent slopes (HcB).**—This soil is thinner than the soil described as representative of the Hollister series and has a lighter colored subsoil. It occurs in narrow bands at the foot of long slopes and on gently sloping, convex ridges within larger areas of Hollister clay loam, 0 to 1 percent slopes. Areas are irregular in shape and from 10 to 60 acres in size. The average gradient is 1.3 percent.

In some low-lying areas, runoff has cut a few shallow gullies, 8 to 14 inches deep and 3 to 8 feet wide. Sheet erosion and rill erosion are common along the rims of these gullies. The rills and gullies can be smoothed over, and further cutting can be controlled if a terrace system is installed and conservation farming is practiced.

Small areas of Hollister clay loam, 0 to 1 percent slopes, and narrow bands of Vernon clay loam are included in this mapping unit. About 5 percent of the acreage has been moderately eroded. (Capability unit IIe-1, dry-farmed; Deep Hardland range site)

## Lincoln Series

This series consists of pale-brown to light reddish-brown, youthful alluvial soils. The parent material consists of stratified material that varies widely in texture but is chiefly coarse sand. The range plants now growing on these soils are little bluestem, sand bluestem, Indian-grass, switchgrass, sand dropseed, alkali sacaton, and saltcedar trees.

The surface layer is light-brown, calcareous loamy fine sand, which is very friable when moist. The subsoil is reddish-brown, structureless loamy fine sand or very fine sand.

Lincoln soils have a sandier subsoil than Yahola soils, with which they are closely associated, and are less red in color. In this county they are separated from stream channels by areas of Sandy alluvial land, which consists of very recent deposits of intermixed sands and clays.

The largest area of Lincoln soils is in the northeastern part of the county on a low bench that parallels the Red River. Most of the acreage has been in cultivation at some time. Because of the low fertility of these soils and their high susceptibility to wind erosion, however, very little of the acreage is now cropped.

Profile of Lincoln loamy fine sand in a cultivated field 2.4 miles east and 0.1 mile north of Fargo:

- A<sub>p</sub> 0 to 7 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) when moist; weak granular structure; slightly hard when dry, very friable when moist; strongly calcareous; clear boundary.
- AC 7 to 21 inches, reddish-brown (5YR 5/4, 4/4 when moist) loamy fine sand; weak granular structure; soft when dry, very friable when moist; strongly calcareous; layer contains thin strata of coarse sand and clay; clear boundary.
- C 21 to 60 inches +, pink (5YR 7/4) coarse sand, reddish yellow (5YR 6/6) when moist; structureless; loose both dry and moist; strongly calcareous.

*Variations.*—The A horizon ranges from 6 to 12 inches in thickness and from reddish brown to light brown, hue 5YR to 7.5YR. The reddish-brown to reddish-yellow AC horizon ranges from very fine sand to loamy fine sand in texture and from 11 to 30 inches in thickness. The depth to coarse river sand is from 20 to 48 inches.

**Lincoln loamy fine sand (ln).**—This soil occurs on weakly undulating, low benches along the Red and Pease Rivers. The surface layer is highly susceptible to wind erosion. In some places, it has been winnowed and shifted into small mounds, 10 to 40 feet across and 1 to 2 feet high. Natural fertility is very low, and saline spots are scattered throughout the area. Small grains, cotton, and alfalfa are grown on the few cultivated areas. Most cultivated crops will not grow on the saline spots, however, and the only plants that will survive on the range or on abandoned cultivated areas are those very tolerant of salts.

About 15 percent of this mapping unit has a fine sandy loam surface layer. Also included are narrow bands of Yahola very fine sandy loam and Norwood clay loam. Crop yields on these inclusions are higher than on Lincoln loamy fine sand. (Capability unit IVe-4, dry-farmed; IVe-1, irrigated; Bottom Land range site)

### Loamy Alluvial Land

**Loamy alluvial land (lo).**—This miscellaneous alluvial land type consists mostly of sediments derived from eroded, higher lying Vernon soils. The range plants now growing on this land type are buffalograss, blue grama, vine-mesquite, little bluestem, Arizona cottontop, and other grasses. Mesquite and hackberry trees dot the landscape.

The soil material is chiefly reddish-brown clay loam and clay over a substratum that contains layers of silt, very fine sandy loam, silty clay loam, and clay loam. A representative area is reached by going 1.5 miles west from the Vernon courthouse and 3.4 miles northwest on U.S. Highway 287, then 2.5 miles west on farm road 925, and 0.6 mile north.

This land type occupies the undulating flood plains immediately adjacent to the major streams and to almost all of the small drains and creeks. These flood plains are inundated frequently in periods of normal rainfall, and channels of small, meandering, intermittent streams are common. Along the channels of some of these small streams, wet spots and saline spots occur. Unless protected against flooding, this land type is suited only to range. (Capability unit Vw-1; Bottom Land range site)

### Mansker Series

This series consists of brown, strongly calcareous, gently sloping, shallow soils that formed in reddish-yellow, old water-laid deposits, or plains outwash. The present range vegetation consists of side-oats grama, blue grama, and clumps of little bluestem and three-awn.

The light-brown surface soil is about 5 inches thick. To a depth of 5 to 16 inches, the subsoil is reddish-brown to brown clay loam that has subangular blocky structure and is very friable when moist. The color becomes somewhat lighter with depth. Both surface soil and subsoil are highly calcareous.

Soils in the Mansker series are not extensive in Wilbarger County. They occur in the northern part along small drains from the higher lying Miles, Springer, Tipton, and Abilene soils and also as oblong areas within areas of these associated soils. Mansker soils are similar to Vernon soils, which formed in red-bed materials, but they are darker colored and less clayey. They are darker colored and less sandy than Cobb soils, which formed in sandy residuum of Permian sandstone.

These shallow soils are low in natural fertility and are very susceptible to water erosion. Most plants that grow on them are yellowish, probably an indication of iron-deficiency chlorosis. Most of the acreage in this county remains in range. Cultivated areas are cropped chiefly to short-season crops, such as oats and sudangrass.

Profile of Mansker loam in a site reached by going 1.7 miles west from the Vernon courthouse and 5.8 miles northwest on U.S. Highway 287, then 6.7 miles north on farm road 432, and 1.6 miles west on farm road 91:

- A<sub>p</sub> 0 to 6 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; weak subangular blocky and granular structure; slightly hard when dry, very friable when moist; strongly calcareous; few, very coarse, hard concretions of calcium carbonate on the surface; abrupt boundary.
- AC 6 to 11 inches, brown (7.5YR 5/4) light clay loam, dark brown (7.5YR 4/4) when moist; weak subangular blocky structure; slightly hard when dry, very friable when moist; strongly calcareous; few fine pores and medium worm casts; clear boundary.
- C<sub>ca</sub> 11 to 52 inches, reddish-yellow (5YR 6/6) heavy clay loam, yellowish red (5YR 4/6) when moist; weak subangular blocky and granular structure; hard when dry, friable when moist; many, coarse, soft and hard lumps and soft concretions of segregated calcium carbonate; few fine pores and medium worm casts; horizon becomes less dark colored with depth; diffuse boundary.
- C 52 to 62 inches +, light-red (2.5YR 6/6) clay loam, red (2.5YR 4/6) when moist; hard when dry, friable when moist; strongly calcareous; few coarse concretions of calcium carbonate.

*Variations.*—The A horizon is reddish brown to brown, hue 5YR to 10YR, and 4 to 6 inches thick. The AC horizon ranges in thickness from 5 to 16 inches and in hue from 5YR to 7.5YR. Depth to C<sub>ca</sub> horizon is from 8 to 22 inches.

**Mansker loam, 1 to 3 percent slopes (McB).**—This soil constitutes about 50 percent of the total acreage of Mansker soils in the county. The gentle convex slopes have an average gradient of 1.8 percent. Most areas are long and narrow, but few are more than 600 feet long.

Both sheet and gully erosion occur in cultivated fields where runoff concentrates. The few shallow gullies, which are about 10 to 16 inches deep, can be partially erased within a few years if a terrace system is installed

and conservation farming is practiced. Moderate yields of wheat are obtained on this soil in years of adequate rainfall.

Included are narrow bands of Miles fine sandy loam, which make up about 2 percent of the mapping unit. Other soils in the Mansker series, particularly Mansker clay loam and Mansker fine sandy loam, are common minor inclusions. (Capability unit IIIe-6, dry-farmed; Mixed Land range site)

**Mansker loam, 3 to 5 percent slopes (McC).**—This soil is almost identical to the soil described as representative of the Mansker series. The short convex slopes have an average gradient of 4 percent. The areas are from 8 to 60 acres in size.

This soil is highly susceptible to both sheet and gully erosion. Very little of the acreage has been cultivated. The few cultivated areas are cropped to oats and sudan-grass and are used for supplemental grazing.

Included are small areas of Miles fine sandy loam and Norwood silt loam, and a few areas of Vernon clay loam. Areas of Mansker clay loam, Mansker fine sandy loam, and Mansker very fine sandy loam are common. These inclusions total less than 5 percent of the acreage. (Capability unit IVe-6, dry-farmed; Mixed Land range site)

**Mansker loam, 5 to 8 percent slopes (McD).**—In much of its area, this soil is darker and grayer in color than the soil described as representative of the series. Water seeping from springs is responsible for the characteristic mottled gray color. This soil is not extensive and occurs in areas less than 30 acres in size. Most of the acreage is in range.

Inclusions, which make up about 3 percent of the acreage, consist of Miles fine sandy loam, less sloping Mansker loams, and Norwood silt loam. (Capability unit VIe-1; Mixed Land range site)

## Miles Series

The Miles series consists of brown to reddish-brown, well-developed, nearly level to gently sloping, moderately sandy soils that have a friable sandy clay loam subsoil. They are well drained and absorb water readily. The parent material consists of yellowish-red, moderately sandy, old water-laid deposits, or plains outwash. The range vegetation on the sandier soils in the series consists mostly of little bluestem, blue grama, sand dropseed, and three-awn and a sparse overstory of mesquite, sand sage, and shinnery oak trees. Shinnery oak and sand sage are usually lacking in the vegetation on the finer textured soils in the series.

The brown surface layer is friable and is either structureless or has granular structure. The reddish-brown, noncalcareous sandy clay loam subsoil has subangular blocky structure. The lower part of the B horizon is lighter colored and more sandy than the upper part.

Miles soils are associated with Springer, Altus, Wichita, Tipton, Cobb, and Enterprise soils. The sandier soils in the Miles series resemble Springer soils but have a more clayey subsoil. They are redder than, but otherwise similar to, Altus soils. The finer textured soils in the Miles series have a less clayey and less blocky subsoil than Wichita soils. They are sandier and lighter colored than

Tipton soils. They are about the same color as Cobb soils, which formed in residuum from Permian sandstone. They are more highly developed than the immature Enterprise soils, which formed in wind-laid deposits and are similar to Miles soils in color.

Soils in the Miles series are among the better soils in the county for cotton and alfalfa. Natural fertility ranges from low to moderate, and crops grown on these soils respond to the use of a complete fertilizer. A large part of the acreage is partially subirrigated; free ground water occurs at a depth of 16 to 24 feet. Miles soils are moderately to highly susceptible to wind erosion, and the more sloping soils in the series are susceptible to water erosion.

Profile of Miles fine sandy loam in a site reached by going 3 miles west from White City on farm road 924, then 0.2 mile south on farm road 432, and 0.2 mile west.

- A<sub>1</sub> 0 to 6 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) when moist; granular structure; slightly hard when dry, very friable when moist; noncalcareous; abrupt boundary.
- B<sub>1</sub> 6 to 18 inches, reddish-brown (5YR 4/3) light sandy clay loam, dark reddish brown (5YR 3/3) when moist; weak subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous; fine pores and medium worm casts common; clear boundary.
- B<sub>2</sub> 18 to 28 inches, reddish-brown (5YR 4/4) heavy sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist; noncalcareous; few fine pores and medium worm casts; clear boundary.
- B<sub>3</sub> 28 to 48 inches, reddish-brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; subangular blocky structure; hard when dry, friable when moist; noncalcareous; few fine pores and medium worm casts; gradual boundary.
- C 48 to 60 inches +, yellowish-red (5YR 5/6, 4/6 when moist) light sandy clay loam; hard when dry, friable when moist; noncalcareous; few ferromanganese concretions.

**Variations.**—The thickness of the A horizon varies according to soil type. In the fine sandy loam, the thickness is from 6 to 14 inches, and in the loamy fine sand, up to 20 inches. The A horizon is brown to reddish brown, hue 5YR to 10YR. The range of texture in the B horizon is from heavy fine sandy loam in the upper part to heavy sandy clay loam in the lower part, which is the zone of maximum accumulation of clay. The B horizon is 20 to 58 inches thick and dark reddish brown to reddish yellow, hue 2.5YR to 7.5YR. The depth to the C horizon ranges from 30 to 70 inches. In about half the acreage of Miles fine sandy loam in Wilbarger County, there is a layer of accumulated calcium carbonate.

**Miles fine sandy loam, 0 to 1 percent slopes (MfA).**—This moderately coarse textured soil is similar to the soil described as representative of the series. It occurs in large areas that have an average gradient of 0.6 percent.

This is one of the most desirable agricultural soils in Wilbarger County. Moisture conditions are excellent, and the soil is easily tilled and worked into a good seedbed. In a few places, where it has been winnowed by wind, the plow layer contains lenses of loamy fine sand.

Except for a few isolated, inaccessible areas, this soil is cultivated, chiefly to cotton, wheat, and alfalfa. All the general crops suited to this county will grow well, either dry-farmed or irrigated.

Small knobs and narrow ridges of Miles loamy fine sand make up about 3 percent of the acreage; some small areas of Altus fine sandy loam are also included. In

about 12 percent of the acreage, the surface layer is loam. These inclusions generally are suited to the same crops and are about as productive as this soil. (Capability unit IIe-3, dry-farmed; IIe-1, irrigated; Mixed Land range site)

**Miles fine sandy loam, 1 to 3 percent slopes (MfB).**—Except for a few areas where the surface layer is less dark colored, this soil is similar to the soil described as representative. It occurs on knolls and ridges. The areas are irregular in shape and range in size from a few acres to 600 acres. The average slope is 1.8 percent.

Moderately high yields of the general crops suited to the county are obtained on this soil. Most of the acreage is cultivated. Cultivated fields are subject to both wind erosion and water erosion. In many areas, wind has winnowed the surface layer and left lenses of loamy fine sand. Gullies, 4 to 8 inches deep and 20 to 50 inches wide, occur on some of the stronger slopes. Along some shallow drains, approximately 50 percent of the original A horizon has been removed by sheet erosion.

Small knobs and narrow bands of other phases of Miles fine sandy loam and small circular knobs of Miles loamy fine sand and Enterprise fine sandy loam make up about 5 percent of the acreage. In about 10 percent of the acreage, the surface layer has a loam texture. (Capability unit IIe-3, dry-farmed; IIe-1, irrigated; Mixed Land range site)

**Miles fine sandy loam, 3 to 5 percent slopes (MfC).**—This soil is thinner than the soil described as representative of the series. The surface layer is less sandy, and the subsoil is more friable. This soil occurs in narrow bands and on ridges in areas of Miles fine sandy loam, 1 to 3 percent slopes, and along drains and tributaries. The average slope is 4 percent.

This is a less desirable soil for farming than the less sloping Miles fine sandy loams. Gullies, 4 to 10 inches deep and 20 to 60 inches wide, have been cut on a few of the stronger slopes. Much of the acreage is cultivated, chiefly to oats and sudangrass for supplemental grazing. Yields of cotton are only fair.

A few small areas of less sloping Miles soils are included, and also some small, moderately eroded areas. These inclusions amount to about 3 percent of the total acreage. (Capability unit IIIe-3, dry-farmed; Mixed Land range site)

**Miles fine sandy loam, 2 to 5 percent slopes, eroded (MfC2).**—This soil differs from the soil described as representative of the series in having a lighter colored surface soil that is only about 3 inches thick. It occupies ridges that have an average slope of 3 percent. Most of these ridges contain several distinct, shallow gullies, which are 50 to 200 feet apart, 8 to 16 inches deep, and 4 to 12 feet wide. For a distance of 20 feet on each side of these gullies, the A horizon has been completely removed by erosion. In some areas the gullies serve as drainageways. Here only the central drain and some 200 feet on either side of the drain, where the surface soil has been almost completely removed and the subsoil exposed in some places, are included in the mapping unit. The areas between the shallow gullies show almost no effects of water erosion.

Most of this soil is cultivated, but yields are low because of erosion. The soil can be greatly improved if erosion

is controlled by installing a terrace system and by using other conservation practices.

Inclusions consist of other soils in the Miles series and amount to about 12 percent of the acreage. (Capability unit IVe-3, dry-farmed; Mixed Land range site)

**Miles fine sandy loam, 5 to 8 percent slopes (MfD).**—This soil has a thinner, less sandy surface layer and a thinner subsoil than the soil described as representative of the series. It occurs in areas parallel to deep drains and their tributaries. The short, concave slopes have an average gradient of 7 percent. Most of the acreage remains in range.

Inclusions consist of narrow bands of Mansker loam and less sloping Miles fine sandy loams and small areas of Norwood silt loam. (Capability unit VIe-1; Mixed Land range site)

**Miles loamy fine sand, 0 to 3 percent slopes (MmB).**—This soil is sandier than the soil described as representative of the series, and the surface layer is thicker by 6 to 14 inches. Free carbonates have been leached from the soil to a depth of 6 to 8 feet. In areas next to or closely associated with Miles fine sandy loam and Altus loamy fine sand, the topography is only gently undulating, and the slopes are long and weakly concave. In areas associated with Springer loamy fine sand, the topography is undulating and a little more strongly sloping.

This soil makes up a little more than 6 percent of the total acreage of Wilbarger County. Most of it is cultivated. If properly managed, it is one of the better soils in the county for alfalfa. Yields of cotton are high if the crop is grown in rotation with alfalfa, guar, mung beans, or Chinese red peas, and fertilizer is applied.

Cultivated fields are highly susceptible to wind erosion, and the texture of the surface layer is altered frequently. In a few areas, the finer soil particles have been removed, and the surface layer is now a fine sand. In a few places, the soil has been blown into small mounds about 2 feet high and 50 to 100 feet in diameter. Along fence rows, the soil accumulations are 4 to 6 feet higher than the surrounding land. It is difficult to measure the soil loss in most places, however, because 80 to 90 percent of the acreage has been plowed to a depth of 14 to 26 inches.

Inclusions consist of narrow bands and oblong knolls or ridges of Springer loamy fine sand, which make up about 3 percent of the acreage; small circular areas of Altus loamy fine sand; and small circular areas and narrow bands of Miles fine sandy loam. About 5 percent of the mapping unit has been moderately eroded. (Capability unit IIIe-5, dry-farmed; IIIe-2, irrigated; Sandy Land range site)

**Miles loamy fine sand, 3 to 5 percent slopes (MmC).**—This soil is thinner than the soil described as representative of the series and has a sandier surface layer. It occurs on high ridges within areas of Miles loamy fine sand, 0 to 3 percent slopes. Slopes are convex and have an average gradient of 4 percent. The areas mapped are narrow and as much as 1,000 feet long.

The surface layer has been thinned by water erosion to about 8 inches. Some crossable shallow gullies and drains, 1 to 2 feet deep and 4 to 12 feet wide, have been cut. Most of the acreage is cropped, chiefly to grain sorghum, sudangrass, and other feed crops.

Small circular areas of Cobb fine sandy loam, shallow variant, and narrow bands of Miles loamy fine sand, 0 to 3 percent slopes, that occur on ridgetops and foot slopes are included. These inclusions amount to less than 3 percent of the acreage. (Capability unit IVe-5, dry-farmed; Sandy Land range site)

## Miller Series

This series consists of reddish-brown, calcareous soils that formed in clayey, recent alluvial sediments derived from Permian red-bed materials. The range plants now growing on these soils are buffalograss, blue grama, vine-mesquite, Texas wintergrass, tobosa, and alkali sacaton and a fairly thick overstory of mesquite trees and lote-bush.

The reddish-brown surface layer has subangular blocky structure. The subsoil consists of calcareous layers that vary widely in texture but are mostly clay and have blocky structure. The subsoil is very hard when dry.

Soils in the Miller series occur on the flood plains of the Red and Pease Rivers and some smaller streams. They are associated with Norwood soils and Port soils. They are finer textured than Norwood soils, which are loamy throughout and have a more stratified subsoil. They are lighter colored and more clayey than Port soils.

Most of the acreage of Miller soils remains in range. Low to moderate yields of small grains are obtained in years of adequate rainfall. If these soils are worked when they are wet, they crust and puddle. If properly managed, however, they retain their good physical condition.

Profile of Miller clay loam in a site reached by going 1.7 miles west from the Vernon courthouse and 3.4 miles northwest on U.S. Highway 287, then 2.5 miles west on farm road 925, and 1.3 miles south, and 0.7 mile east:

A<sub>1p</sub> 0 to 7 inches, reddish-brown (5YR 5/4, 4/4 when moist) clay loam; weak, very fine, subangular blocky structure; hard when dry, very friable when moist; weakly calcareous; has a surface crust one-fourth to one-half inch thick; abrupt boundary.

A<sub>1s</sub> 7 to 14 inches, reddish-brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) when moist; weak, fine to medium, subangular blocky structure; hard when dry, friable when moist; weakly calcareous; common fine pores and fine to medium worm casts and channels; clear boundary.

AC 14 to 60 inches +, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; compound structure—moderate medium blocky and moderate fine irregular blocky; very hard when dry, very firm when moist; strongly calcareous; few splotches of calcium carbonate between peds; few very fine pores.

**Variations.**—The clay loam to clay A horizon is 10 to 22 inches thick. In a few areas it is noncalcareous. The AC horizon is dominantly heavy clay loam or clay, but, in many areas, this horizon is less clayey and more sandy at a depth of 24 to 30 inches.

**Miller clay loam (Mt).**—This soil occurs on higher lying alluvial plains that are not flooded frequently but receive runoff from adjacent slopes. There are a few slight depressions on these otherwise nearly level plains.

A good part of the acreage is in range. Moderate yields of small grains are obtained on the cultivated areas of this soil that are dry-farmed. Good yields of most of the general crops can be expected if they can be irrigated. Only a small acreage is now irrigated.

Inclusions of Miller clay in small sloughs and of Norwood clay loam make up less than 2 percent of the acreage. Loamy alluvial land, which occurs as channels of small intermittent streams, makes up about 5 percent of the mapping unit. (Capability unit IIe-1, dry-farmed; I-2, irrigated; Bottom Land range site)

**Miller clay (Mr).**—This soil contains more clay throughout the solum than the soil described as representative of the series. It is very droughty; water moves through the soil very slowly, and, at a depth of 20 inches or more, the soil is almost always dry. It is difficult to till, and it forms a poor seedbed. Only low yields of cultivated crops can be expected in extremely wet or extremely dry years. Most of the acreage remains in range consisting chiefly of tobosa.

Small areas of Miller clay loam and Norwood clay loam are included and make up 4 percent of the acreage. (Capability unit III-2, dry-farmed; Bottom Land range site)

## Norwood Series

This series consists of deep, reddish-brown to brown, calcareous, friable soils. They formed in silty and fine-grained, recent alluvial sediments derived from Permian red-bed materials. The range plants now growing are blue grama, Arizona cottontop, vine-mesquite, little bluestem, and buffalograss. Mesquite and hackberry trees dot the landscape.

The surface layer is reddish brown, calcareous, granular, and very friable (fig. 8). The deep subsoil consists of stratified, calcareous layers of silty clay loam, silt loam, and very fine sandy loam.

Soils in the Norwood series are the most extensive bottom land soils in Wilbarger County. They occur on the flood plains of the Red and Pease Rivers and smaller streams. They have a sandier subsoil than the associated Miller soils, which are similar in color. They are not so sandy throughout the solum as Yahola soils, which also have a similar color. They are redder than Port soils.

These highly productive soils give excellent yields of most of the general crops grown in the county. If well managed, they retain their good physical condition. If they are farmed when they are too wet, however, they puddle and get a hard surface crust when they dry out. A large part of the acreage in this county remains in range.

Profile of Norwood clay loam in a site 2 miles south and 2.1 miles east of Farmers Valley:

A<sub>1</sub> 0 to 12 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; compound structure—weak subangular blocky and granular; upper 2 inches are fine platy; hard when dry, friable when moist; weakly calcareous; fine pores and medium worm casts common; gradual boundary.

AC 12 to 60 inches +, reddish-brown (5YR 4/3) strata, a few inches to 10 or 12 inches thick, of silt loam, very fine sandy loam, and silty clay loam, dark reddish-brown (5YR 3/3) when moist; hard when dry, friable when moist; strongly calcareous; common fine pores; common worm casts.

**Variations.**—The A horizon ranges from 8 to 28 inches in thickness, from silt loam to clay loam in texture, and from reddish brown to brown, hue 2.5YR to 7.5YR. In a few areas it is noncalcareous.

**Norwood clay loam (Nc).**—This soil makes up almost 96 percent of the acreage of Norwood soils in Wilbarger

County. It occurs on the higher lying alluvial plains that are not flooded frequently. Most areas are several miles long and between 400 and 2,500 feet wide. The average gradient is less than 0.5 percent.

This is one of the better soils in the county for cultivated crops. It is easily tilled and worked into a good seedbed. Yields of crops, dry-farmed or irrigated, are excellent.

Inclusions consist of small areas of Miller clay loam, which make up 2 percent of the acreage; Norwood silt loam, about 6 percent; Yahola very fine sandy loam, about 3 percent; and Miller clay, about 1 percent. (Capability unit I-1, dry-farmed; I-1, irrigated; Bottom Land range site)

**Norwood silt loam (No).**—This soil occurs mostly in wide, smooth, nearly level bands along the Red River. Its surface layer is less clayey and 4 to 6 inches thicker than that in the soil described as representative of the Norwood series.

This soil is easily tilled and worked into a good seedbed, but a plowpan is likely to be formed if the soil is plowed and cultivated to the same depth most of the time. Almost the entire acreage is cultivated. Very high yields of dry-farmed cotton and alfalfa are produced.

Inclusions of Norwood clay loam and Yahola very fine sandy loam make up about 2 percent of the mapping unit. (Capability unit I-1, dry-farmed; I-1, irrigated; Bottom Land range site)

## **Oil-Waste Land**

**Oil-waste land (Ow).**—This miscellaneous land type consists of areas on which liquid wastes from oil wells and drilling operations, chiefly oil and salt water, have accumulated. These areas, most of which are more than 5 acres in size, occur mainly along small tributaries. Some adjacent uplands, however, have also been affected.

Most of the acreage, 60 to 90 percent of which has no plant cover, is not suited to agriculture. Some areas can be reclaimed, however, and seeded to grasses suited to the particular site. (Capability unit VIIIs-1; Rough Breaks range site)

## **Port Series**

This series consists of deep, brown to dark-brown, friable soils. The parent material consists of recent alluvial sediments that were derived from the higher lying Abilene, Hollister, and Miles soils. The range plants now growing on these soils are blue grama, side-oats grama, buffalograss, switchgrass, little bluestem, and other grasses.

The surface layer is brown to dark brown, noncalcareous, and very friable and has granular structure. The subsoil is strongly calcareous and not so dark colored. It consists of layers of sediments of various textures and ordinarily extends to a depth of 6 feet or more.

In Wilbarger County, soils in the Port series occupy the flood plains of Wanderers, Paradise, and Adams Creeks. They are associated with Norwood and Miller soils. Port soils have a darker colored surface layer than Norwood soils. They are darker colored and less clayey than Miller soils.

Port soils are highly productive. In this county only small, inaccessible areas remain in range.



Figure 8.—Profile of Norwood clay loam. The A horizon is 18 inches thick; the AC horizon extends from 18 to 50 inches.

Profile of Port clay loam in a cultivated field reached by going 2 miles south from Odell on farm road 432, then 1.5 miles west on farm road 91, and 0.4 mile north:

- A<sub>1</sub> 0 to 6 inches, dark-brown (7.5YR 4/2, 3/2 when moist) clay loam; compound structure—weak subangular blocky and granular; hard when dry, friable when moist; noncalcareous; abrupt boundary.
- A<sub>2</sub> 6 to 16 inches, dark-brown (7.5YR 4/2, 3/2 when moist) heavy silty clay loam; weak subangular blocky structure; hard when dry, friable when moist; noncalcareous; many fine and very fine pores; medium worm casts and channels common; clear boundary.
- AC 16 to 60 inches +, reddish-brown (5YR 5/4) light sandy clay loam, 10 inches thick, over a dark grayish-brown (10YR 4/2) layer of sandy clay loam on a reddish-brown silty clay loam layer; strongly calcareous; hard when dry, friable when moist; few, medium, soft concretions of calcium carbonate.

**Variations.**—The A horizon ranges from 16 to 35 inches in thickness and from brown to dark grayish brown, hue 7.5YR to 10YR. The AC horizon ranges in texture from fine sandy loam to light clay and from reddish brown to dark brown, hue 5YR to 10YR.

**Port clay loam (Pc).**—This soil occurs in large, continuous, nearly level areas on flood plains. It is easily tilled and worked into a good seedbed. The natural fertility is high. Moisture conditions are exceptionally good. Other than maintenance of fertility and good tilth, no special conservation practices are necessary on this soil. It produces very high yields of alfalfa, wheat, and cotton, either dry-farmed or irrigated.

Inclusions consist of small, irregular areas of Norwood clay loam, which make up less than 2 percent of the acreage, and Loamy alluvial land, 8 percent. (Capability unit I-1, dry-farmed; I-1, irrigated; Bottom Land range site)

## Rough Broken Land

**Rough broken land, clayey (Rb).**—This miscellaneous land type consists mostly of Permian red-bed clays and shales that have been exposed by geologic erosion. Most of the area is further dissected by V-shaped gullies. Some areas are smoother, but they are "scalded" and support very little vegetation. Generally, above the gullied areas and adjacent to the upland plains, there is a sharp escarpment. Although this is a distinct topographic feature, it is very narrow and its total acreage is relatively small.

Over most of the area the slope is from 5 to 10 percent, but the walls of the V-shaped gullies have a gradient of 20 to 60 percent. From 60 to 70 percent of the land type consists of the areas within these gullies. Small red-berry junipers and clumps of tobosa grow on the narrow interridges and knobs. In some areas there is a gravel erosion pavement, beneath which the red beds have been partially weathered to a depth of 2 to 5 inches. Some soil material, chiefly aggregates or soil particles the size of sand, has accumulated in the bottoms of some gullies that have a nonerosive grade. A few mid grasses grow in these places. On the whole, this land type has more value for winter range than is commonly believed or than seems possible from casual observation.

Some areas of Vernon complex and of Vernon clay loam, which are capable of greater grass production, are included in the broad gullied areas. Although fencing these areas and managing them separately may not be worth while, their use would materially increase the weighted carrying capacity of any large pasture that consists mostly of Rough broken land, clayey.

A representative area of this land type is in a pasture reached by going 2 miles south from Farmers Valley on a rural road, then 1.7 miles west, and 0.7 mile south. (Capability unit VII-1; Rough Breaks range site)

**Rough broken land, loamy (Ro).**—This land type consists of Enterprise very fine sandy loams on the steep, relatively smooth escarpments adjacent to the Red and Pease Rivers. The slopes range from 8 to 90 percent but in most areas are about 20 percent. Several deeply dissected gullies, 10 to 60 feet deep and 5 to 30 feet wide, occur.

Except for a few minor areas, all this land type is in range. Part of it is not accessible to livestock, even though it supports an excellent growth of little bluestem. Below the thick, wind-laid, sandy mantle are areas of Rough broken land, clayey. These inaccessible and clayey areas are small and make up only a small proportion of the acreage in the mapping unit.

A representative area of Rough broken land, loamy, is reached by going 0.1 mile west from Doans, then 1.1 miles north, and 0.1 mile east. (Capability unit VIe-1; Mixed Land range site)

## Sandy Alluvial Land

**Sandy alluvial land (Sa).**—This miscellaneous land type consists of mixed alluvium, dominantly very fine sandy loam in texture, that was deposited in an erratic and irregular manner along the Pease and Red Rivers. It forms low, narrow ridges and valleys parallel to the river channels. Fresh alluvial sediments are deposited once or twice during most 5-year periods. The rivers meander across the alluvium, and large areas are completely reworked from time to time. In many places, the surface layer contains a considerable amount of salt, as shown by the thick overstory of saltcedar. Switchgrass grows luxuriantly on areas that have been cleared of saltcedar, and sand bluestem grows on the sandier spots.

A representative area of this land type is on the south side of the Pease River, 1.8 miles north of the Vernon courthouse on U.S. Highway 283. (Capability unit Vw-1; Bottom Land range site)

## Springer Series

This series consists of well-drained, brown to reddish-brown, sandy soils that formed in moderately sandy, old alluvium that has been reworked by wind. They occur mostly on gently rolling plains, but nearly level areas, 50 to 200 acres in size, are also common. The range plants now growing are little bluestem, sand bluestem, side-oats grama, blue grama, and three-awn.

The surface layer is brown to reddish brown, noncalcareous, and very friable when moist. The reddish-brown subsoil is heavy fine sandy loam and is slightly more compact than the surface layer. The subsoil is lighter in color and sandier at a lower depth.

Springer soils have a sandier subsoil than Miles soils. They are redder and less sandy than Tivoli soils.

Soils in the Springer series absorb water readily. Characteristically, they are leached of all free carbonates to a depth of about 8 feet. A large part of the acreage of Springer soils in Wilbarger County is subirrigated; free water occurs at a depth of 16 to 24 feet. These soils are easily tilled, but they are highly susceptible to wind erosion and, where runoff concentrates on the steeper slopes, to water erosion. Natural fertility is very low, but crops respond well to the application of a complete fertilizer. Yields of cotton are fair, and yields of alfalfa are good.

Profile of Springer loamy fine sand in a site 1 mile east and 1 mile north of the junction of farm road 91 and U.S. Highway 283:

- A<sub>1</sub>. 0 to 20 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) when moist; structureless (single grained) or weak granular structure; loose when dry; noncalcareous; pH 7.0; many very fine root hairs; gradual boundary.
- B<sub>1</sub>. 20 to 38 inches, reddish-brown (5YR 5/4) heavy fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak subangular blocky structure; slightly hard when dry, friable when moist; noncalcareous; pH 7.0; a few fine pores; diffuse boundary.
- B<sub>2</sub>. 38 to 56 inches, reddish-brown (5YR 5/4, 4/4 when moist) fine sandy loam; weak subangular blocky structure;

slightly hard when dry, friable when moist; noncalcareous; pH 7.0; gradual boundary.

C 56 to 62 inches +, reddish-yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 5/6) when moist; loose; noncalcareous; pH 7.0.

**Variations.**—The A horizon is 6 to 24 inches thick and light brown to yellowish brown, hue 7.5YR to 10YR. The texture of the B horizon is dominantly fine sandy loam, but it ranges from light fine sandy loam to light sandy clay loam. This horizon is 20 to 54 inches thick and reddish brown to yellowish brown, hue 5YR to 7.5 YR. In some places, there is a B<sub>1</sub> horizon. Depth to the C horizon ranges from 32 to 64 inches. Dark-brown, buried soil horizons occur in these soils in many places.

**Springer loamy fine sand, undulating (Sp).**—This soil makes up nearly three-fourths of the acreage of Springer soils in the county. Low mounds, less than 36 inches high, dot the otherwise fairly smooth surface. These mounds have a slope of about 2 percent.

This sandy soil is highly susceptible to wind erosion. In some cultivated fields, wind has removed the finer soil particles in the surface layer and left a fine sand. There are a few sandy mounds, 8 to 14 inches high. Much of this sandy material has been blown and redeposited along fence rows in mounds now 3 to 6 feet high. It is difficult to measure the actual soil loss, since a large part of the acreage has been plowed to a depth of 20 to 26 inches.

If it is properly managed, this is one of the better soils in the county for alfalfa. Yields of cotton, either dry-farmed or irrigated, are fair if cotton is grown in a rotation that includes properly fertilized alfalfa, guar, mung beans, Chinese red peas, or grasses.

Inclusions consist of irregular-shaped areas of Miles loamy fine sand, about 4 percent of the total acreage; oblong areas, 1 to 5 acres in size, of Springer fine sandy loam, about 2 percent; and a few small, moderately eroded areas of Springer loamy fine sand. (Capability unit IVe-4, dry-farmed; IVe-1, irrigated; Sandy Land range site)

**Springer loamy fine sand, hummocky (Sg).**—This soil resembles very closely the soil described as representative of the Springer series. It occurs as irregular, choppy, high ridges within broad areas of Springer loamy fine sand, undulating. The average gradient is 6 percent. Areas of this soil ordinarily are irregular or oblong in shape and from 20 to 200 acres in size.

Most of the acreage remains in range. In areas that have been cultivated, about 30 percent of the original surface layer has been removed by wind erosion, and there are some sandy mounds, 12 to 30 inches high.

About 2 percent of this soil is moderately eroded. Also included are narrow bands of Springer loamy fine sand, undulating, which occur on ridgetops and foot slopes and make up about 6 percent of the total acreage. Where this soil is closely associated with Miles soils, some small knobs and narrow bands of Miles loamy fine sand are included. (Capability unit VIe-2; Sandy Land range site)

## Tillman Series

This series consists of deep, reddish-brown soils that developed in calcareous red-bed clays and shales. The present range vegetation consists of buffalograss, tobosa, prairie three-awn, and a thick overstory of mesquite trees.

The reddish-brown, noncalcareous surface soil is 4 to 8 inches thick (fig. 9). It is friable and has granular struc-

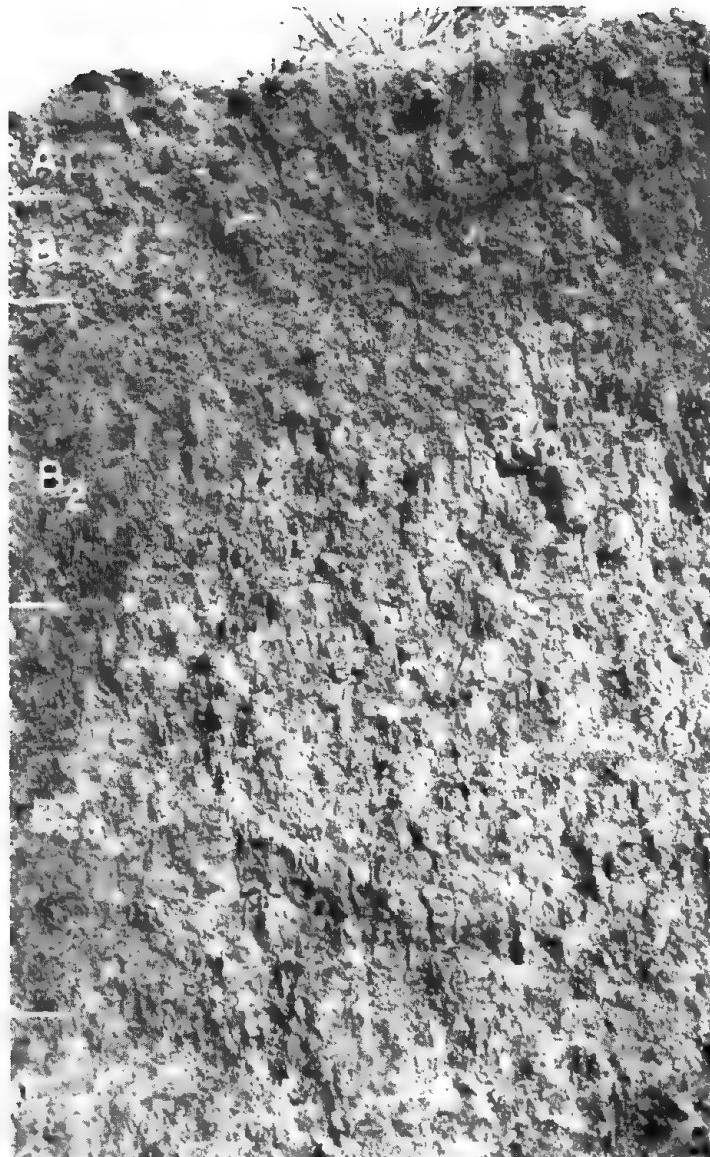


Figure 9.—Profile of Tillman clay loam. The A horizon is 6 inches thick; the B<sub>1</sub> horizon extends from 6 to 10 inches; the B<sub>2</sub> horizon, from 10 to 22 inches; and the B<sub>ca</sub> horizon, from 22 to 36 inches.

ture. The subsoil extends to an average depth of 50 inches. The upper part is reddish-brown, noncalcareous light clay that has subangular blocky structure. The lower part is reddish-brown, blocky clay, more dense and more compact than the upper part. This horizon grades to a layer that contains nodules of lime.

Soils in the Tillman series are extensive in Wilbarger County. They occur throughout the southern third of the county, mostly on nearly level to gently rolling high plains that are interrupted only by permanent drains and tributaries. They are associated with Hollister, Wichita, and Vernon soils. Tillman soils are redder than the lower lying Hollister soils and have a thinner, less distinct B<sub>1</sub> horizon. They are more clayey and less friable than the higher lying Wichita soils. They are deeper than the calcareous Vernon soils, which occur on lower lying and generally more sloping areas parallel to the drains.

Tillman soils are moderately productive. They are fertile but have poor moisture relationships. They are very droughty because of the thin surface soil and the dense, clayey subsoil. They are best suited to wheat and grain sorghum. About 85 percent of the total acreage in Wilbarger County remains in range.

Profile of Tillman clay loam in a site reached by going 8.8 miles south from the Vernon courthouse on U.S. Highway 283, then 2 miles west, 2.8 miles south, and 0.4 mile southeast on rural road, and 1.1 miles southeast on pasture road:

- A<sub>1</sub> 0 to 6 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; weak granular structure; hard when dry, friable when moist; noncalcareous; few fine and very fine pores; few worm casts; clear boundary.
- B<sub>1</sub> 6 to 10 inches, reddish-brown (5YR 4/3) light clay, dark reddish brown (5YR 3/3) when moist; moderate, fine and medium, subangular blocky structure; very hard when dry, firm when moist; noncalcareous; common very fine pores, few worm casts; clear boundary.
- B<sub>2</sub> 10 to 22 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) when moist; moderate, medium, blocky and irregular blocky structure; extremely hard when dry, very firm when moist; noncalcareous; few very fine pores; gradual boundary.
- B<sub>3a</sub> 22 to 36 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; moderate, medium, blocky and irregular blocky structure; extremely hard when dry, very firm when moist; strongly calcareous; common very fine and fine concretions of calcium carbonate; few very fine pores; gradual boundary.
- C<sub>1a</sub> 36 to 46 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) when moist; extremely hard when dry, very firm when moist; common, fine, hard and soft concretions of calcium carbonate; gradual boundary.
- C 46 to 52 inches +, red (2.5YR 4/6), partially weathered, strongly calcareous red-bed clays; dark red (2.5YR 3/6) when moist.

**Variations.**—The A horizon is reddish brown to brown, hue 5YR to 7.5YR. The B horizon ranges from 15 to 55 inches in thickness, from heavy clay loam to clay in texture, and from 2.5YR to 5YR in hue. The structure ranges from subangular blocky in the B<sub>1</sub> horizon to irregular blocky in the B<sub>2</sub> horizon. In about 40 percent of the acreage, the soil has no B horizon. The depth to the B<sub>3a</sub> horizon ranges from 14 to 28 inches, and the depth to the C<sub>1a</sub> horizon, from 24 to 52 inches. The C horizon is from 2 to 6 feet below the surface.

**Tillman clay loam, 0 to 1 percent slopes (TcA).**—This soil has a darker colored surface soil and a thicker subsoil than the soil described as representative of the Tillman series. It occurs on nearly level uplands in areas 10 to 500 acres in size. Slopes are weakly convex and have an average gradient of 0.7 percent.

Because this soil is nearly level, there is very little water erosion. During rains of high intensity, water accumulates in low-lying areas and remains there for several days. It is difficult to prepare a good seedbed on this soil unless moisture conditions are good. If cultivated, it is best suited to small grains and grain sorghum. About 90 percent of the acreage remains in range.

Small ridges of Tillman clay loam, 1 to 3 percent slopes, make up about 4 percent of the acreage. Some circular areas of Foard clay loam, which is not mapped separately in this county, and some lower lying, oblong areas of Hollister clay loam are also included but are of small extent. (Capability unit IIe-1, dry-farmed; Deep Hardland range site)

**Tillman clay loam, 1 to 3 percent slopes (TcB).**—This soil makes up almost 80 percent of the total acreage of Tillman soils in the county. It occurs in irregular, elongated areas, 10 to 600 acres in size, on gently rolling ridges. Slopes are convex and have an average gradient of 1.6 percent.

Runoff is high because of the slow rate of infiltration. Where runoff concentrates in cultivated fields, several shallow, fingerlike gullies have formed. These gullies ordinarily are 8 to 10 inches deep and 3 to 8 feet wide. The surface soil along the side slopes has been thinned somewhat by erosion. These areas can be smoothed over and further cutting controlled if a terrace system is installed and conservation farming is practiced. It is difficult to prepare a good seedbed on this soil unless moisture conditions are good. Most of the acreage remains in range.

Knolls and narrow bands of Vernon clay loam and some small areas of Foard clay loam and of Hollister clay loam are included. A few areas of the eroded phase of this soil, less than 5 acres in size, are also included. These inclusions make up about 10 percent of the acreage. (Capability unit IIIe-1, dry-farmed; Deep Hardland range site)

**Tillman clay loam, 1 to 3 percent slopes, eroded (TcB2).**—This soil is of very minor extent. It consists of areas of Tillman clay loam in which several fingerlike gullies feed into a central, broad, shallow gully or drain. The central gullies are 1 to 3 feet deep and 10 to 25 feet wide. Most of the surface soil and part of the subsoil has been removed over an area that extends several feet on each side of these gullies. Most of this erosion has resulted from poor management. The uneroded areas of Tillman clay loam that lie between these gullies make up about 10 percent of the acreage.

This soil can be greatly improved and further erosion controlled if a terrace system is installed and conservation farming is practiced. The best protection would be a cover of suitable grasses. (Capability unit IVe-1, dry-farmed; Deep Hardland range site)

## Tipton Series

This series consists of deep, brown to dark-brown, friable soils that developed in calcareous, silty or loamy, old alluvium. In Wilbarger County, soils in this series occur on low terraces along the Red and Pease Rivers.

The surface layer is brown to dark brown, granular, and very friable when moist. The subsoil is dark-brown, very friable clay loam that has moderate, medium, subangular blocky structure. In some places, the lower part of the subsoil contains a few nodules of lime.

Tipton soils are darker colored and less sandy than Enterprise soils, which lack a developed B horizon. They are darker colored and less sandy than Miles soils, which developed in plains outwash, and darker colored and less sandy than Springer soils, which developed in wind-laid material. Tipton soils are less clayey than Abilene soils, which are similar in color and developed in moderately fine textured plains outwash. They are less sandy than Altus soils, which developed in sandy outwash materials.

Soils in the Tipton series are well suited to most of the general crops grown in the county. Except in years of inadequate rainfall, continuous high yields can be ex-

pected. Almost all the acreage is cultivated. The tall and mid grasses suited to the general area also grow luxuriantly on these soils.

Profile of Tipton silt loam in a site 1.5 miles north of Elliott:

- A<sub>1p</sub> 0 to 6 inches, brown (7.5YR 5/4) silt loam, dark brown (7.5YR 4/4) when moist; weak granular structure; slightly hard when dry, very friable when moist; noncalcareous; abrupt boundary.
- A<sub>1s</sub> 6 to 14 inches, dark-brown (10YR 4/3, 3/3 when moist) loam; compound structure—weak prismatic and weak granular; slightly hard when dry, very friable when moist; noncalcareous; many very fine and fine pores; many worm casts; clear boundary.
- B<sub>1</sub> 14 to 24 inches, dark-brown (7.5YR 4/2, 3/2 when moist) light sandy clay loam; weak subangular blocky structure; hard when dry, friable when moist; noncalcareous; many very fine and fine pores; common worm casts; gradual boundary.
- B<sub>2</sub> 24 to 38 inches, dark-brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; hard when dry, firm when moist; few very fine pores; weakly calcareous; diffuse boundary.
- B<sub>ca</sub> 38 to 56 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; strongly calcareous; common threads and films of calcium carbonate; a few very fine pores; gradual boundary.
- C<sub>ca</sub> 56 to 100 inches +, light-gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) when moist; hard when dry, friable when moist; strongly calcareous; many, coarse, hard, white concretions of calcium carbonate, which constitute 15 percent of the soil mass.

*Variations.*—The A horizon ranges in thickness from 6 to 22 inches and from brown to dark brown, hue 7.5YR to 10YR. The B horizon ranges in texture from light sandy clay loam to silty clay loam and in thickness from 10 to 56 inches. The dry color of the B horizon ranges from dark reddish brown to dark grayish brown, hue 5YR to 10YR, but is dominantly 7.5YR. Depth to the C<sub>ca</sub> horizon is 38 to 65 inches. Buried soil horizons, at a depth of 3 feet or more, are common.

**Tipton silt loam, 0 to 1 percent slopes (TpA).**—This nearly level soil constitutes about three-fourths of the acreage of Tipton soils in the county. It occurs in narrow, elongated areas of 60 to 500 acres. The concave slopes have an average gradient of 0.4 percent.

This soil absorbs most of the rain that falls. During rains of high intensity, some runoff accumulates in the lower lying areas, but it is soon absorbed and stored in the lower subsoil. This is one of the most desirable soils in the county. High yields of most crops can be expected, either dry-farmed or irrigated. Cotton, wheat, and alfalfa are the principal crops.

Narrow bands of Enterprise very fine sandy loam; oblong knolls of Miles fine sandy loam; weakly concave areas of Abilene clay loam; and a few knolls and narrow bands of Tipton silt loam, 1 to 3 percent slopes, are included. These inclusions constitute about 10 percent of the total acreage. They are about as productive and are suited to the same crops as this soil. (Capability unit I-1, dry-farmed; I-1, irrigated; Mixed Land range site)

**Tipton silt loam, 1 to 3 percent slopes (TpB).**—This soil is slightly lighter colored and has a thinner surface layer than the soil described as representative of the series. It occurs in narrow, elongated bands on the gently sloping ridges that lie above the nearly level areas of Tipton silt loam. Ordinarily, the slopes are convex and have an average gradient of 1.8 percent.

This soil absorbs most of the rain that falls, but runoff concentrates during rains of high intensity. A few shallow gullies, 8 to 12 inches deep and 40 to 80 inches wide, have been cut in unprotected fields. Most of these can be partially smoothed over within a few years and further cutting controlled if a terrace system is installed and conservation farming is practiced. Cotton, wheat, and alfalfa are the chief crops grown on this soil. Good yields of most crops can be expected in years of adequate rainfall.

Inclusions consist of narrow bands and oblong areas of Tipton silt loam, 0 to 1 percent slopes, which make up 4 percent of the acreage, and a few oblong knobs of Mansker loam, which amount to less than 1 percent. (Capability unit IIe-2, dry-farmed; Mixed Land range site)

## Tivoli Series

This series consists of light-colored, weakly developed, noncalcareous, loose sands. The parent materials are wind-laid sands. The present range vegetation consists of a moderate growth of sand sagebrush and a fair cover of little bluestem, big bluestem, and sand dropseed.

The surface layer is reddish-brown to brown fine sand. The subsoil is reddish-yellow to strong-brown fine sand that, in some places, extends to a depth of 7 or 8 feet. The lower part of this horizon is lighter colored than the upper part.

Tivoli soils are less red and more sandy than the associated lower lying Springer soils. They are more sandy than Enterprise soils, which occupy similar positions. They are closely associated with Lincoln and Yahola soils, which occur on the flood plains of the Red and Pease Rivers.

In Wilbarger County, soils in the Tivoli series occur mostly in the northern part, in an area about a mile wide adjacent to the bank of the Red River. Almost the entire acreage is in range.

Profile of Tivoli fine sand in a site 20.2 miles north of the Vernon courthouse on U.S. Highway 283:

- A<sub>1</sub> 0 to 14 inches, brown (7.5YR 5/4) fine sand, dark brown (7.5YR 4/4) when moist; weak granular structure; loose when dry; very friable when moist; noncalcareous; clear boundary.
- C 14 to 100 inches +, reddish-yellow (7.5YR 7/6, 6/8 when moist) fine sand; structureless; loose both dry and moist; noncalcareous.

*Variations.*—The A horizon is 12 to 20 inches thick and reddish brown to brown, hue 5YR to 7.5YR. It is dominantly noncalcareous, but in some places it is weakly calcareous. The C horizon is strong brown to reddish yellow, hue 5YR to 7.5YR. In a few places this horizon is calcareous.

**Tivoli fine sand (Tv).**—This soil consists of large subdued dunes that are separated by small valleys in a very complex, hummocky pattern. The dunes are as much as 30 feet high and 10 to 200 feet wide. The average gradient is 1.5 percent.

This soil readily absorbs any rain that falls. It is very low in natural fertility and is highly susceptible to wind erosion. Almost all the acreage is in range, which is its best agricultural use.

A few areas of Springer loamy fine sand and a few active dunes of Tivoli fine sand, eroded, are included. These inclusions amount to less than 5 percent of the total acreage. (Capability unit VIIe-1; Sandy Land range site)



Figure 10.—Profile of Vernon clay loam. The A horizon is 8 inches thick; the AC horizon extends from 8 to 18 inches.

### Vernon Series

This series consists of reddish-brown, calcareous, shallow soils that developed in partially weathered clays and shales of Permian red beds. The present range vegetation consists of a fair cover of buffalograss, tobosa, and side-oats grama, and scattered dwarf mesquite trees.

To a depth of 8 inches or less (fig. 10), the surface soil is reddish brown, weakly calcareous, and very friable when moist. This layer has weak, fine, subangular blocky structure. The subsoil, to a depth of about 16 inches, is reddish-brown to red light clay, which is slightly more compact than the surface soil, has blocky structure, and is hard when dry and firm when moist. Nodules of lime occur throughout this layer.

Soils in the Vernon series occur on the smoother, less eroded, narrow bands, low ridges, and knobs within and adjacent to areas of the deeper Tillman, Hollister, Abilene,

and Wichita soils. They are more clayey and less friable than Mansker soils, which developed in plains outwash, and Cobb soils, which are noncalcareous and developed in fine-grained material weathered from sandstone.

Vernon soils are low in natural fertility, very droughty, and highly erodible. They are used mostly for range or for pasture.

Profile of Vernon clay loam in a pasture reached by going 1.4 miles southeast from Grayback on farm road 1811, then 2 miles south, 2 miles southwest, and 0.1 mile north:

- A<sub>1</sub> 0 to 4 inches, reddish-brown (5YR 5/4, 4/4 when moist) clay loam; weak subangular blocky structure; hard when dry, friable when moist; weakly calcareous; many very fine and fine pores; clear boundary.
- AC 4 to 15 inches, reddish-brown (5YR 5/4, 4/4 when moist) light clay; weak to moderate subangular blocky and blocky structure; hard when dry, firm when moist; strongly calcareous; common fine and very fine pores; clear boundary.
- C<sub>a</sub> 15 to 24 inches, yellowish-red (5YR 5/6, 4/6 when moist) clay; moderate, fine to medium, subangular blocky and blocky structure; very hard when dry, very firm when moist; strongly calcareous; many, medium, hard and soft concretions of calcium carbonate; gradual boundary.
- C 24 to 30 inches +, reddish-brown (5YR 4/6), partially weathered, red-bed clays; dark red (5YR 3/6) when moist.

*Variations.*—The reddish-brown A horizon is 3 to 8 inches thick. It is noncalcareous in a few areas. The AC horizon is 7 to 16 inches thick, reddish brown to dark reddish brown, hue 2.5YR to 5YR, and a heavy clay loam or clay. In a few areas, there is no C<sub>a</sub> horizon.

**Vernon clay loam, 2 to 5 percent slopes (VcC).**—This gently sloping soil occurs in long, narrow bands. The average gradient is 2.8 percent. The soil is highly susceptible to water erosion. In most cultivated areas, the surface soil has been thinned 2 to 3 inches by sheet erosion. Where runoff has concentrated during rains of high intensity, a few shallow gullies have formed. Much of the surface soil has been removed from overgrazed rangeland.

Most of the acreage remains in range. Yields of cultivated crops are low. Most farmers seed cultivated areas to sudangrass or to small grains for supplemental grazing.

Inclusions consist of small areas of Vernon complex, which make up about 8 percent of the acreage, and of Tillman clay loam, about 5 percent. The inclusions do not materially affect the productivity of this soil. (Capability unit VIe-3; Shallow Hardland range site)

**Vernon complex (Vx).**—This complex is about 55 percent Vernon clay loam and 45 percent exposed red-bed clays and shales. Other than some slight weathering to a depth of 2 or 3 inches in a few places, the clayey red-bed materials show no soil development. The complex occurs mostly in the southern third of the county, chiefly on escarpments and in broad, eroded valleys along drains and tributaries. The adjoining higher land is occupied by the deeply developed Abilene, Hollister, and Tillman soils, and the flood plains in the valleys are occupied by Loamy alluvial land, Norwood soils, and Miller soils. The overall topography is undulating and complex. Vernon clay loam occurs on the smoother ridges and knobs, and the clayey red-bed materials along the eroded escarpments, in shallow gullies, and on the side slopes of the knobs and ridges. Interbedded sandstone, limestone conglomerates, cemented

calcium carbonate, and stones are common throughout the area.

This complex is highly susceptible to water erosion. From 50 to 75 percent of the acreage has enough soil or soil material to support a fair cover of buffalograss, tobosa, side-oats grama, and scattered dwarf mesquite trees. In a few places, further cutting of the shallow gullies has been checked by vegetation. In some places, eroded soil material has been deposited to a depth of 20 inches or more. All the acreage is in range, its best use. (Capability unit VIe-3; Shallow Hardland range site)

## Wichita Series

This series consists of brown to reddish-brown soils that developed in calcareous old alluvium, or plains outwash, derived in part from clayey red beds. The range plants now growing are buffalograss, blue grama, tobosa in scattered clumps, side-oats grama, and prairie three-awn.

The surface soil is brown to reddish brown and noncalcareous (fig. 11). It is slightly hard when dry but breaks easily to granular structure. The upper part of the subsoil is reddish-brown, very hard, noncalcareous, blocky and subangular blocky heavy clay loam. The lower part is reddish-brown, blocky clay loam that is not so compact as the upper part and contains some soft nodules of lime.

Soils in the Wichita series occur on nearly level plains and gently rolling ridges along small streams and high terraces in the southern and eastern parts of Wilbarger County. They are lighter colored than the associated Abilene soils, which developed in similar materials. They have a more clayey subsoil than Miles soils, which also developed in the same kind of material. They are more clayey than Cobb soils, which developed in residuum from Permian sandstones.

Profile of Wichita clay loam in a site reached by going east 0.75 miles from Harrold on U.S. Highway 287, then 1.6 miles east on Texas Highway 240:

- A<sub>a</sub> 0 to 8 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; weak granular structure; slightly hard when dry, very friable when moist; noncalcareous; abrupt boundary.
- B<sub>1</sub> 8 to 15 inches, reddish-brown (5YR 4/4) heavy silty clay loam, dark reddish brown (5YR 3/4) when moist; weak subangular blocky structure; hard when dry, friable when moist; noncalcareous; many very fine pores; few worm casts; clear boundary.
- B<sub>2</sub> 15 to 26 inches, reddish-brown (5YR 4/4) heavy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist; strongly calcareous; few very fine concretions of calcium carbonate; common very fine pores; few worm casts; gradual boundary.
- B<sub>ca</sub> 26 to 38 inches, reddish-brown (5YR 4/4) heavy clay loam, dark reddish brown (5YR 3/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; strongly calcareous; common, coarse, soft concretions of calcium carbonate make up 4 percent of the soil mass; very few fine pores; gradual boundary.
- C 38 to 52 inches +, red (2.5YR 4/6) silty clay, dark red (2.5YR 3/6) when moist; calcareous old alluvium derived in part from clayey red beds.

**Variations.**—The A horizon is 3 to 8 inches thick and is reddish brown to brown, hue 5YR to 7.5YR. The B horizon ranges in texture from clay loam to light clay and in thickness from 8 to 32 inches. It is reddish brown and ranges in hue from 2.5YR to 5YR. Depth to the B<sub>ca</sub> horizon ranges from 18 to 35

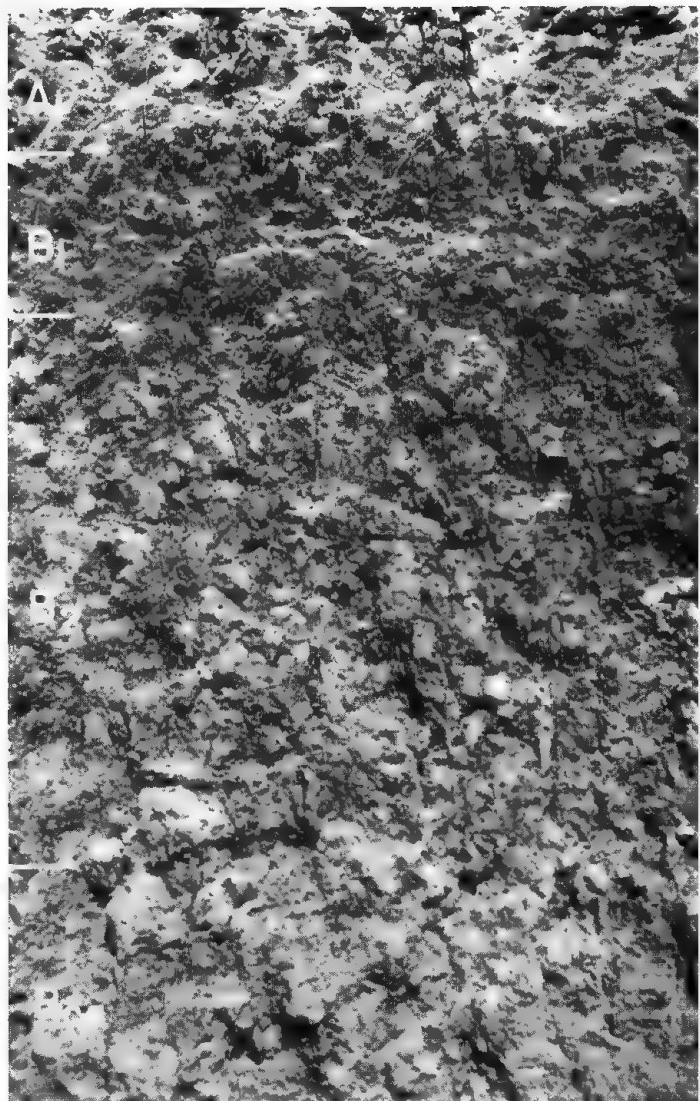


Figure 11.—Profile of Wichita loam. The A horizon is 6 inches thick; the B<sub>1</sub> horizon extends from 6 to 13 inches; the B<sub>2</sub> horizon, from 13 to 26 inches; and the B<sub>ca</sub> horizon, from 26 to 40 inches.

inches. Depth of the C horizon ranges from 32 to 60 inches. The parent material is variable. In some places it is silty, and in others it is clayey.

**Wichita clay loam, 0 to 1 percent slopes (WcA).**—This nearly level soil is almost identical to the soil described as representative of the series. The convex slopes have an average gradient of 0.6 percent. The areas are oblong to circular, have smooth boundaries, and are 20 to 250 acres in size.

This soil is easily tilled and worked into a good seedbed. It is moderately fertile, and water erosion is not a problem. Cultivated areas produce moderate yields of most of the general crops. The principal crops are wheat and cotton.

Small, weakly concave areas of Abilene clay loam make up as much as 2 percent of the acreage. Some small areas of Wichita clay loam, 1 to 3 percent slopes, are also included. (Capability unit IIc-1, dry-farmed; I-2, irrigated; Deep Hardland range site)

**Wichita clay loam, 1 to 3 percent slopes (WcB).**—This soil constitutes about 88 percent of the acreage of Wichita soils in the county. It occurs in irregular, elongated areas along ridges and drains. The convex slopes have an average gradient of 1.8 percent.

Cultivated areas of this soil show some evidence of sheet and gully erosion. The original surface layer in the steeper areas has been thinned 2 or 3 inches. Concentration of runoff on some of the weakly concave side slopes has caused a few shallow gullies. These can be partially erased within a few years and further cutting prevented if a terrace system is installed and conservation farming is practiced. This soil is moderately fertile, but much of the rain that falls is lost as runoff. Consequently, yields of most of the general crops are lower than those on Wichita clay loam, 0 to 1 percent slopes. Wheat and cotton are the principal crops.

Inclusions of Abilene clay loam, along smooth foot slopes and shallow drains, make up about 4 percent of the total acreage. About 6 percent consists of small areas and narrow bands of Vernon clay loam on ridgetops and foot slopes. (Capability unit IIe-1, dry-farmed; Deep Hardland range site)

**Wichita loam, 0 to 1 percent slopes (WmA).**—This less extensive soil occurs along the low terraces of Boggy, Paradise, and China Creeks. It is darker colored and has a less clayey surface layer than the soil described as representative of the series. The average gradient is 0.5 percent.

There is very little runoff. During rains of high intensity, however, water accumulates in low-lying areas. This soil is easily tilled and worked into a good seedbed. If it is always cultivated or plowed to the same depth, a plowpan is likely to be formed. This soil is moderately fertile, and cultivated areas produce moderate yields of most of the general crops in years of adequate rainfall. Cotton and wheat are the principal crops.

Small, weakly convex knolls of Wichita and Miles fine sandy loams are included. They constitute about 5 percent of the total acreage. (Capability unit IIc-1, dry-farmed; I-2, irrigated; Mixed Land range site)

## **Yahola Series**

This series consists of calcareous, moderately sandy, reddish-brown soils that formed in recent sandy alluvium. In Wilbarger County, soils in this series occur close to the streambanks on the flood plains of the Red and Pease Rivers. Most of the acreage is cultivated, and the soils will produce a good cover of all the mid and tall grasses suited to the general area.

The surface layer is reddish brown and weakly calcareous and has granular structure. It is slightly hard when dry. The subsoil is reddish-brown very fine sandy loam that is very friable when moist.

These soils are sandier than the associated Norwood soils. They are redder than Lincoln soils and have a less sandy subsoil. They are sandier than the clayey Miller soils and are not so red.

Profile of Yahola very fine sandy loam in a site reached by going 1.5 miles west and 3.4 miles northwest from the Vernon courthouse on U.S. Highway 287, then 2.5 miles

west on farm road 925, 2 miles south, 0.2 mile west, 0.3 mile south on rural road, and 0.8 mile south on field road:

A<sub>1a</sub> 0 to 6 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) when moist; compound structure—weak granular and weak subangular blocky; slightly hard when dry, very friable when moist; strongly calcareous; abrupt boundary.

A<sub>1b</sub> 6 to 16 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) when moist; compound structure—weak coarse prismatic and weak subangular blocky; slightly hard when dry, very friable when moist; strongly calcareous; many fine pores; common medium worm casts; gradual boundary.

AC 16 to 60 inches +, reddish yellow (5YR 6/6), yellowish red (5YR 4/6) when moist; texture, structure, and consistence same as for A<sub>1b</sub> horizon; common fine pores and medium worm casts; strongly calcareous; few threads and films of calcium carbonate.

**Variations.**—The A horizon is 14 to 32 inches thick and reddish brown to brown, hue 5YR to 7.5YR. The reaction to acid is variable, from weak to very strong. The depth to the AC horizon ranges from 14 to 32 inches. This horizon is red to yellowish red, hue 2.5YR to 5YR.

**Yahola very fine sandy loam (Yc).**—This soil occupies a nearly level alluvial plain. The average gradient is 0.4 percent. This soil is one of the most desirable soils for farming in the county. It is easily tilled. It absorbs water readily; any water that accumulates in low-lying areas during rains of high intensity remains there only a few hours. The soil is highly productive and is well suited to most cultivated crops, either dry-farmed or irrigated. Alfalfa and cotton are the chief crops.

Narrow bands of Norwood silt loam and Norwood clay loam make up about 4 percent of the acreage. Less extensive inclusions consist of narrow bands of Lincoln soils and Sandy alluvial land, which occur next to the stream channels, and some gently sloping, weakly convex ridges and small knolls of Yahola soils. (Capability unit I-1, dry-farmed; I-1, irrigated; Bottom Land range site)

## **Use and Management of the Soils**

This section has eight parts. In the first, the capability classification, in which the soils are grouped according to their suitability for most kinds of farming, is explained, and the capability groups in Wilbarger County are defined. In the second part, management of the soils is discussed by capability units. In the third, the general management practices for cropland are discussed; and a brief description of irrigation in the county is given in the fourth. The fifth part lists the estimated yields of crops on the different soils under two levels of management. The sixth discusses the use and management of the soils for range. The seventh discusses the use of field windbreaks and the suitability of the soils for the different trees planted in windbreaks. A few practices for the establishment of wildlife habitats and farm ponds are listed in the eighth part. The engineering uses of the soils are discussed in a following section.

## **Capability Groups of Soils**

The capability classification is a grouping of soils that shows, in a general way, how suitable they are for most kinds of farming. It is a practical grouping based on the

limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels—the capability class, the subclass, and the unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and land-forms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited because it is shallow, droughty, or stony; and *c*, used only in some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are subject to little or no erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife habitats.

Within the subclasses are the capability units—groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping of soils for making many statements about their management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIe-2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major, and generally expensive, land-forming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and units in Wilbarger County, are described in the list that follows. The descriptive name gives the general nature of the principal soils in the capability unit. Because irrigation is used to only a minor extent in the county, capability units for irrigated farming are listed only for the soils for which water is now available. The soils in each unit are listed in the discussion of management by capability units.

**Class I. Soils that have few limitations that restrict their use.**

Capability unit I-1, dry-farmed; I-1, irrigated.—Deep, well-drained, nearly level soils that have a friable subsoil.

**Class II. Soils that can be used for tilled crops but have some limitations that reduce the choice of plants or require moderate conservation practices.**

Subclass IIe. Soils that are limited for the production of crops by insufficient effective rainfall.

Capability unit IIe-1, dry-farmed; I-2, irrigated.—Deep, well-drained, nearly level soils that have a firm, blocky subsoil.

Subclass IIe. Soils subject to slight or moderate erosion if they are not protected.

Capability unit IIe-1.—Deep, well-drained, gently sloping soils that have a firm, blocky subsoil.

Capability unit IIe-2.—Deep, well-drained, gently sloping, medium-textured soils that have a friable, medium-textured to moderately fine textured subsoil.

Capability unit IIe-3, dry-farmed; IIe-1, irrigated.—Deep, well-drained, nearly level to gently sloping, moderately coarse textured soils that have a moderately fine textured subsoil.

Capability unit IIe-4, dry-farmed; IIe-2, irrigated.—Deep, well-drained, nearly level soils that are moderately coarse textured throughout.

Subclass IIs. Soils that are moderately limited by droughtiness and require simple moisture-conservation practices.

Capability unit IIs-1.—Deep, moderately well drained, moderately fine textured soils that have a compact, fine-textured subsoil and very slow internal drainage.

**Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.**

Subclass IIIe. Soils subject to moderately severe erosion if they are cultivated and not protected.

Capability unit IIIe-1.—Deep, moderately well drained, gently sloping, moderately fine textured soils that have a fine-textured, compact subsoil and very slow internal drainage.

Capability unit IIIe-2.—Deep, well-drained, gently to moderately sloping soils that are medium textured and friable throughout.

Capability unit IIIe-3.—Deep, well-drained, gently to moderately sloping, moderately coarse textured soils that have a moderately fine textured subsoil.

Capability unit IIIe-4, dry-farmed; IIIe-1, irrigated.—Deep, well-drained, gently sloping soils that are moderately coarse textured throughout.

Capability unit IIIe-5, dry-farmed; IIIe-2, irrigated.—Deep, well-drained, nearly level to gently sloping, coarse-textured soils that have a moderately fine textured subsoil.

Capability unit IIIe-6.—Shallow, well-drained, gently sloping, medium-textured soils that have a moderately fine textured subsoil.

Capability unit IIIe-7.—Deep, dark-colored, nearly level, coarse textured soils that have a moderately fine textured subsoil.

Subclass IIIIs. Soils severely limited by salinity or droughtiness.

Capability unit IIIIs-1.—Deep, moderately well drained, nearly level to gently sloping soils that have a high content of salts in the surface layer.

Capability unit IIIIs-2.—Deep, nearly level, fine-textured soils that have a compact subsoil and very slow internal drainage.

Subclass IIIIw. Soils severely limited by excess water and salinity.

Capability unit IIIIw-1.—Deep, nearly level to gently sloping, poorly drained, slightly saline, moderately coarse textured soils.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe. Soils subject to severe erosion if cultivated and not protected.

Capability unit IVe-1.—Deep, moderately well drained, gently sloping, moderately fine textured soils that have a compact, fine-textured subsoil and very slow internal drainage.

Capability unit IVe-2.—Deep, well-drained, sloping soils that are friable and medium textured throughout.

Capability unit IVe-3.—Deep, well-drained, moderately sloping, moderately coarse textured soils that have a moderately fine textured subsoil.

Capability unit IVe-4, dry farmed; IVe 1, irrigated.—Deep, well-drained, nearly level to gently sloping, coarse-textured soils that have a moderately coarse textured subsoil.

Capability unit IVe-5.—Deep, well-drained, moderately sloping, coarse-textured soils that have a moderately fine textured subsoil.

Capability unit IVe-6.—Shallow, well-drained, gently to moderately sloping, medium-textured soils that have a moderately fine textured subsoil.

Class V. Soils that are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass Vw. Soils too wet for cultivation.

Capability unit Vw-1.—Frequently flooded, deep, poorly drained, saline soils on bottom lands.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe. Soils severely limited by the risk of erosion if protective cover is not maintained.

Capability unit VIe-1.—Well-drained, sloping, medium-textured and moderately coarse textured soils that have a medium-textured to moderately fine textured subsoil.

Capability unit VIe-2.—Deep, well-drained, moderately sloping to steeply sloping, coarse-textured soils that have a moderately coarse textured subsoil.

Capability unit VIe-3.—Shallow and very shallow, moderately sloping soils that are moderately fine textured throughout.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation, and that restrict their use largely to grazing, woodland, or wildlife habitats.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.

Capability unit VIIe-1.—Moderately sloping to steeply sloping sandy soils.

Subclass VIIIs. Soils or land types very severely limited by uneven topography or other soil features.

Capability unit VIIIs-1.—Moderately sloping to steeply sloping, raw, clayey soil materials in which there is little or no soil development.

Class VIII. Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial production of plants, and restrict their use to recreation, wildlife habitats, water supply, or esthetic purposes. (There is no class VIII land in Wilbarger County.)

## Management by Capability Units

The soils in one capability unit have about the same limitations and similar risks of damage. The soils in any one unit, therefore, need about the same kind of management. In the following pages, the soils in each capability unit are listed, and some suggestions for their management are made.

### *Capability unit I-1, dry-farmed; I-1, irrigated*

This unit consists of deep, well-drained, reddish-brown to dark-brown, nearly level soils that have a friable subsoil. The soils are—

Enterprise very fine sandy loam, 0 to 1 percent slopes.  
Norwood clay loam.  
Norwood silt loam.  
Port clay loam.  
Tipton silt loam, 0 to 1 percent slopes.  
Yahola very fine sandy loam.

These soils are fertile and permeable to water and plant roots. They have a high capacity to hold both water and plant nutrients. They are slightly susceptible to wind erosion, or blowing. Hence, it is desirable to maintain a good supply of organic matter in these soils and to keep an adequate cover on their surface.

Yields of all the general crops grown on these soils are high. Cotton and wheat are the principal cash crops. Alfalfa is also grown, generally in a 4- or 5-year rotation, for hay and as a soil-improving crop. Ordinarily, however, alfalfa does not grow vigorously after midsummer, because of the lack of rainfall.

If the soils are dry-farmed, use a cropping system in which a high-residue crop, such as a small grain or grain sorghum, is grown a fourth of the time. Grow a soil-improving crop, such as alfalfa, guar, winter peas, or vetch, a sixth of the time. Stubble mulching will help to control blowing, to reduce evaporation of soil moisture, to add organic matter to the soil, and to aid in the retention of any rain that falls.

On irrigated cropland, grow a soil-improving crop about a fourth of the time. Fertilizer is needed for high yields. The amount to be applied depends on the soil and the crop to be grown and can be determined by soil tests.

#### **Capability unit IIc-1, dry-farmed; I-2, irrigated**

This unit consists of deep, well-drained, reddish-brown to dark-brown, nearly level soils that have a firm, blocky subsoil. The soils are—

Abilene clay loam, 0 to 1 percent slopes.  
Hollister clay loam, 0 to 1 percent slopes.  
Miller clay loam.  
Wichita clay loam, 0 to 1 percent slopes.  
Wichita loam, 0 to 1 percent slopes.

These soils are fertile and have a high capacity to hold moisture and plant nutrients. The compact subsoil, however, is slowly permeable to water and roots, and the soils are somewhat droughty. Lack of sufficient rainfall is the chief hazard to dryfarming.

Wheat and cotton are the main cash crops. Grain sorghum, alfalfa, barley, and oats are also grown, but less extensively.

If the soils are dry-farmed, it is important to keep adequate cover on the surface and to maintain the organic-matter supply. Use a cropping system that includes a small grain or grain sorghum a fourth of the time. Part of the cultivated land should be in high-residue crops like these each year. Grow winter peas, hubam sweetclover, or Madrid sweetclover as a soil-improving crop about a sixth of the time. Stubble mulching will help to prevent evaporation of moisture from the soil and aid in the retention of rainfall, as well as help to maintain the organic-matter supply. A terrace system will help to hold rainwater and allow more of it to soak into the soil.

On irrigated cropland, fertilizer containing nitrogen and phosphorus is needed for sustained high yields. The amount to be applied depends on the soil and the crop to be grown and can be determined by soil tests.

#### **Capability unit IIe-1, dry-farmed**

This unit consists of deep, well-drained, reddish-brown to dark-brown, gently sloping, moderately fine textured soils that have a firm, blocky subsoil. These soils are—

Abilene clay loam, 1 to 3 percent slopes.  
Hollister clay loam, 1 to 3 percent slopes.  
Wichita clay loam, 1 to 3 percent slopes.

These soils are fertile. They have a high water-holding capacity, but the slowly permeable subsoil restricts the movement of water and roots. In years of inadequate rainfall, the soils are droughty. Ordinarily, they are only slightly susceptible to water erosion, but losses of both soil and water may be high during rains of high intensity. The chief management requirements are controlling erosion, conserving moisture, and maintaining soil fertility.

Wheat and cotton are the chief cash crops. Grain sorghum, alfalfa, barley, and oats are also grown, but less extensively.

Terracing and contour farming will help to minimize the erosion hazard. So will a cropping system that includes a high-residue crop, such as wheat or grain sorghum, about a third of the time. A soil-improving crop, such as winter

peas, hubam sweetclover, or Madrid sweetclover, should be grown about a fifth of the time.

An alternative, if a terrace system is not installed, is to use a cropping system in which a drilled high-residue crop is grown two-thirds of the time. Stubble mulch, and grow a soil-improving crop about a fifth of the time. Applications of fertilizer should be based on soil tests and crop requirements.

These soils are suited to irrigation, but water is not now available.

#### **Capability unit IIe-2, dry-farmed**

This unit consists of reddish-brown to brown, deep, well-drained, gently sloping, medium-textured soils that have a friable, medium-textured to moderately fine textured subsoil. The soils are—

Enterprise very fine sandy loam, 1 to 3 percent slopes.  
Tipton silt loam, 1 to 3 percent slopes.

These soils are fertile and permeable to moisture and roots. Except during high-intensity rains, they absorb most of the rain that falls. Because of the gentle slope, the risk of water erosion is only slight. The soils are slightly susceptible to wind erosion. The chief management requirements are maintaining fertility and controlling erosion.

Cotton and wheat are the chief cash crops. Alfalfa is grown in a 4- or 5-year rotation for hay and as a soil-improving crop. It does not grow vigorously after midsummer.

Terracing and contour farming will help to control water erosion. The cropping system should include a soil-improving crop, such as alfalfa, winter peas, guar, or vetch, about a sixth of the time. This will help to maintain fertility and to improve the physical condition of the soil. A properly managed high-residue crop, grown about a third of the time, will help to control wind erosion.

An alternative, if a terrace system is not installed, is to grow a drilled high-residue crop about half the time and to stubble mulch. This will aid in the absorption and retention of rainfall. In this system, a soil-improving crop should be grown 1 year in every 6 years. Applications of fertilizer should be based on soil tests and crop requirements.

These soils are suited to irrigation, but water is not now available.

#### **Capability unit IIe-3, dry-farmed; IIe-1, irrigated**

This unit consists of deep, brown to reddish-brown, well-drained, moderately coarse textured, nearly level to gently sloping soils that have a moderately fine textured subsoil. The soils are—

Altus fine sandy loam.  
Miles fine sandy loam, 0 to 1 percent slopes.  
Miles fine sandy loam, 1 to 3 percent slopes.

These soils are easily tilled and moderately permeable to moisture and plant roots. They are moderately susceptible to wind erosion. The gently sloping soil is slightly susceptible to water erosion. The natural fertility is moderately low. The chief management requirements are conservation of moisture, control of erosion, and maintenance of fertility.

Cotton and wheat are the chief cash crops. Alfalfa is also grown, chiefly in a 4- or 5-year rotation, for hay and as a soil-improving crop. Ordinarily, alfalfa yields are lower after midsummer because of the shortage of moisture.

If the soils are dry-farmed, the cropping system should include a high-residue crop about a third of the time. The residues, properly managed, will help to control wind erosion and to maintain the organic-matter supply. Keeping the surface roughened and cloddy during the critical erosion periods will also help to control blowing. A soil-improving crop, such as alfalfa, guar, mung beans, or winter peas, should be grown about a fifth of the time. These crops help to maintain the organic-matter supply and to improve the physical condition of the soil. Installation of a complete terrace system and farming on the contour will help to control water erosion.

If the soils are irrigated, a soil-improving crop should be grown about a fourth of the time. Commercial fertilizer is necessary for continued high production. The amount to be applied should be based on soil tests and crop requirements.

#### ***Capability unit IIe-4, dry-farmed; IIe-2, irrigated***

This unit consists of a reddish-brown to brown, deep, well-drained, moderately coarse textured, nearly level soil. The soil is—

Enterprise fine sandy loam, 0 to 1 percent slopes.

This soil is easily tilled. It is readily permeable to water and roots and soaks up almost all the rain that falls. It is moderately susceptible to erosion. The natural fertility is moderately low. The chief management requirements are control of erosion and maintenance of fertility.

Cotton and wheat are the chief cash crops. Alfalfa is also grown in a 4- or 5-year rotation for hay and as a soil-improving crop. After midsummer, alfalfa yields are lower because of the lack of moisture.

If the soil is dry-farmed, the cropping system should include a high-residue crop about a third of the time. The residues will help to maintain the organic-matter content of the soil and will provide cover that will help to control wind erosion. Growing alfalfa, guar, mung beans, or winter peas a fourth of the time will help to improve the physical condition of the soil and also help to maintain the organic-matter content.

On irrigated cropland, a soil-improving crop should be grown about a third of the time. Commercial fertilizer is necessary to maintain high yields. The kind and the amount to be applied should be determined by soil tests and crop requirements.

#### ***Capability unit IIe-1, dry-farmed***

This unit consists of a reddish-brown, deep, moderately well drained, moderately fine textured, nearly level soil that has a compact, fine-textured subsoil and very slow internal drainage. The soil is—

Tillman clay loam, 0 to 1 percent slopes.

This soil is fertile but has poor tilth. It is droughty because of the thin surface soil and the dense, blocky clay subsoil that restricts the movement of water. The

principal management problems are reducing evaporation, increasing the intake of water, and maintaining the organic-matter content of the soil.

Wheat is the chief cash crop. Grain sorghum and barley are also grown, but less extensively.

A conservation cropping system for this soil includes a high-residue crop about half the time. If properly managed, the residues will help to reduce evaporation, to maintain the organic-matter content, and to increase the intake of water. Growing winter peas, hubam sweetclover, Madrid sweetclover, or a similar soil-improving crop, about a fifth of the time will help to improve tilth and help to maintain the supply of organic matter.

This soil is suited to irrigation, but water is not now available.

#### ***Capability unit IIIe-1, dry-farmed***

This unit consists of a reddish-brown, deep, moderately well drained, moderately fine textured, gently sloping soil that has a compact, fine-textured subsoil and very slow internal drainage. The soil is—

Tillman clay loam, 1 to 3 percent slopes.

The natural fertility of this soil is high, but tilth is poor. Because of the thin surface layer and the dense, blocky clay subsoil, the soil is droughty. Most of the rainfall runs off. Consequently, the soil is slightly to moderately susceptible to water erosion. The chief management problems are controlling water erosion, reducing evaporation, increasing the intake of water, and maintaining the organic-matter content of the soil.

Wheat is the chief cash crop. Barley and grain sorghum are also grown, but less extensively.

Installing a terrace system and farming on the contour will help to control erosion. The cropping system should include a high-residue crop about two-thirds of the time. The residues, if properly managed, will help to prevent evaporation, to increase infiltration of water, and to maintain the organic-matter content of the soil. A soil-improving crop, such as winter peas, hubam sweetclover, or Madrid sweetclover, should be grown about a fifth of the time to add organic matter and to improve tilth.

If a terrace system is not installed, a drilled high-residue crop should be grown each year. Stubble mulching will provide protective cover as well as help to maintain the organic-matter content and to increase the amount of water taken in by the soil. A soil-improving crop should be grown about a third of the time. Applications of fertilizer should be based on soil tests and crop requirements.

This soil is suitable for irrigation, but water is not now available.

#### ***Capability unit IIIe-2, dry-farmed***

This unit consists of a reddish-brown, deep, well-drained, gently sloping to moderately sloping soil that is medium textured and friable throughout. The soil is—

Enterprise very fine sandy loam, 3 to 5 percent slopes.

This soil is fertile and easily tilled. It is very permeable to water and plant roots. It is moderately susceptible to water erosion and slightly susceptible to wind erosion. The chief management problems are controlling erosion, conserving moisture, and maintaining fertility. The chief crops are wheat and cotton.

Installing a complete terrace system and farming on the contour will help to control water erosion. The cropping system should then include a high-residue crop about half the time. If properly managed, the residues will help to maintain the organic-matter content of the soil and will also provide cover to protect the soil against blowing. During critical wind erosion periods, the surface of the soil should be kept rough and cloddy. A soil-improving crop should be grown about a fifth of the time. Applications of fertilizer should be based on soil tests and crop needs.

This soil is suitable for irrigation, but water is not now available.

#### ***Capability unit IIIe-3, dry-farmed***

This unit consists of deep, reddish-brown, moderately coarse textured, gently to moderately sloping soils that have a moderately fine textured subsoil. The soils are—

Cobb fine sandy loam, 1 to 3 percent slopes.

Miles fine sandy loam, 3 to 5 percent slopes.

The natural fertility of these soils is moderately low. They are permeable to water and roots and are moderately susceptible to both wind erosion and water erosion.

The principal crops are grain sorghum and sudangrass. Cotton is also grown, but yields are low.

Installing a complete terrace system and farming on the contour will help to control water erosion. The cropping system should be one that keeps a drilled high-residue crop, such as small grain, on at least half the cropland each year. The residues, if properly managed, will help to control wind erosion and to maintain or increase fertility. A soil-improving crop, such as guar, alfalfa, mung beans, or winter peas, should be grown about a fifth of the time to improve tilth and to help to maintain the organic-matter content. Applications of fertilizer should be based on soil tests and crop requirements.

These soils are suitable for irrigation, but water is not now available.

#### ***Capability unit IIIe-4, dry-farmed; IIIe-1, irrigated***

This unit consists of a reddish-brown to brown, deep, well-drained, gently sloping soil that is moderately coarse textured throughout. The soil is—

Enterprise fine sandy loam, 1 to 3 percent slopes.

This soil is permeable to water and roots and soaks up most of the rainfall. It is moderately susceptible to wind erosion and slightly susceptible to water erosion. The natural fertility is moderately low. The principal management problems are controlling erosion, conserving moisture, increasing fertility, and maintaining the organic-matter content. The chief crops are cotton and grain sorghum.

If the soil is dry-farmed, the cropping system should include a high-residue crop, such as grain sorghum or a small grain, two-thirds of the time. If properly managed, the residues will help to maintain the organic-matter content as well as provide cover to protect the soil against blowing, especially during the critical erosion periods. The surface of the soil should be kept rough and cloddy during these periods. A soil-improving crop, such as alfalfa, guar, mung beans, or winter peas, should be grown about a fifth of the time.

If the soil is irrigated, a soil-improving crop should be grown about half the time. Commercial fertilizer is necessary to maintain high yields. The amount to be applied should be determined by soil tests and crop requirements.

#### ***Capability unit IIIe-5, dry-farmed; IIIe-2, irrigated***

This unit consists of a brown, deep, well-drained, nearly level to gently sloping, coarse-textured soil that has a moderately fine textured subsoil. The soil is—

Miles loamy fine sand, 0 to 3 percent slopes.

This soil is moderately permeable to water and plant roots. It is highly susceptible to wind erosion. The natural fertility is low. The principal management problems are maintaining fertility and the organic-matter content, conserving moisture, and protecting the soil against erosion.

Cotton and alfalfa are the chief cash crops. Alfalfa is grown both for hay and as a soil-improving crop.

If the soil is dry-farmed, the cropping system should include a high-residue crop, such as grain sorghum or a small grain, at least half the time. The residues, if properly managed, will help to maintain the organic-matter content of the soil and also help to protect the soil against blowing.

A soil-improving crop, such as guar, alfalfa, mung beans, and vetch, should be grown about a fourth of the time. Deep plowing will help to maintain a cloddy surface for emergency control of wind erosion, but the benefits are only temporary.

If the soil is irrigated, a soil-improving crop should be grown 1 year in every 3 years. Commercial fertilizer is necessary for continued high production. The amount to be applied should be determined by soil tests and crop requirements.

#### ***Capability unit IIIe-6, dry-farmed***

This unit consists of a brown, shallow, well-drained, gently sloping, medium-textured soil that has a moderately fine textured subsoil. The soil is—

Mansker loam, 1 to 3 percent slopes.

This soil has a low capacity to store both water and plant nutrients, because of its shallowness. The natural fertility is low, and the soil is droughty. Because of the gentle slope, the risk of water erosion is only slight. The principal management requirements are conserving moisture, controlling erosion, and maintaining fertility and the organic matter content. Sudangrass, small grains, and grain sorghum are the principal crops.

Installing a terrace system and farming on the contour will help to control erosion. The cropping system should include a high-residue crop about half the time. If properly managed, the residues will help to maintain the organic-matter content of the soil and to reduce evaporation. Fertilizer should be applied according to soil tests and crop requirements.

This soil is suitable for irrigation, but water is not now available.

#### ***Capability unit IIIe-7, dry-farmed***

This unit consists of a brown to dark-brown, deep, nearly level, coarse-textured soil that has a moderately fine textured subsoil. The soil is—

Altus loamy fine sand.

This soil is readily permeable to water and plant roots. Ordinarily, the supply of available plant nutrients is moderately low. The risk of wind erosion is moderately high. In some places, the surface layer is more sandy because it has been winnowed by the wind. The principal management requirements are protection against blowing and maintenance of the organic-matter content.

Cotton and alfalfa are the chief cash crops. Farmers commonly grow alfalfa both for hay and for soil improvement. Yields are high, even in years of low rainfall.

The cropping system should include a high-residue crop, such as a small grain or grain sorghum, about half the time. If properly managed, the residues will help to control wind erosion and to maintain the organic-matter content. A soil-improving crop, such as alfalfa, guar, mung beans, or vetch, should be grown about a fourth of the time. The surface of the soil should be kept rough and cloddy during the critical erosion periods, and adequate cover should be maintained. Commercial fertilizer is necessary for continued high yields. The amount to be applied should be determined by soil tests and crop requirements.

This soil is suitable for irrigation, but water is not now available.

#### ***Capability unit IIIw-1, dry-farmed***

This unit consists of a complex in which the soils are brown to dark brown, deep, moderately well drained, moderately fine textured, and nearly level to gently sloping. The complex is—

##### *Abilene-slickspot complex.*

These soils have a high content of salts in the surface layer, and they get a hard surface crust when dry. Tilth is poor, and most of the rainfall runs off. The soils are slightly susceptible to water erosion. The principal management problems are reducing evaporation, increasing the infiltration of water, and maintaining the organic-matter content.

Small grain and sudangrass are the chief crops. Yields are low, however, even in years of adequate rainfall.

If the soils are cropped, a complete terrace system is needed to help to control erosion. A soil-improving crop should be grown about a third of the time to help to improve the physical condition of the soil and to maintain the organic-matter content. The rest of the time, a high-residue crop, such as a small grain, should be grown. The residues, if properly managed, will help to reduce erosion, to increase the intake of water, and to maintain the organic-matter content. Fertilizer applications should be based on soil tests and crop requirements.

The soils of this complex are suitable for irrigation, but water is not now available.

#### ***Capability unit IIIw-2, dry-farmed***

This unit consists of a reddish-brown, deep, fine-textured, nearly level soil that has a compact subsoil and very slow internal drainage. The soil is—

##### *Miller clay.*

This soil is droughty and hard to till. It forms a poor seedbed unless the plow layer has the right amount of moisture. The surface seals over and crusts, and the soil absorbs water very slowly. Hence, most of the rainfall

runs off. The principal management problems are improving tilth, reducing evaporation, and increasing the intake of water.

Most of the acreage is in range. Small grains and sudangrass are the chief crops in cultivated areas.

The cropping system should include a high-residue crop, such as a small grain, about half the time and a soil-improving crop about a fourth of the time. These crops will help to reduce evaporation, to increase the infiltration of water, to maintain the organic-matter content, and to improve physical condition. Fertilizer applications should be based on soil tests and crop requirements.

This soil is suitable for irrigation, but water is not now available.

#### ***Capability unit IIIw-1, dry-farmed***

This unit consists of a brown to dark-brown, deep, moderately coarse textured, poorly drained, nearly level to gently sloping soil. The soil is—

##### *Altus fine sandy loam, poorly drained variant.*

Because of the fairly high content of salts in the surface layer, this soil readily seals over and crusts. The natural fertility is very low. During droughts, there is a slight risk of wind erosion. The principal management problems are drainage, increasing fertility, and improving the physical condition of the soil. Small grains and sudangrass are the chief crops.

A soil-improving crop, such as alfalfa, should be grown about a third of the time and a high-residue crop, such as a small grain, the rest of the time. These crops will help to maintain the organic-matter content and to improve the physical condition of the soil. The residues will help to reduce evaporation and crusting. Subsurface drainage is needed to remove the excess water. Fertilizer applications should be based on soil tests and crop requirements.

This soil does not need irrigation.

#### ***Capability unit IVe-1, dry-farmed***

This unit consists of a reddish-brown, deep, gently sloping, moderately fine textured soil that has a compact, fine-textured subsoil and very slow internal drainage. The soil is—

##### *Tillman clay loam, 1 to 3 percent slopes, eroded.*

This soil has a high supply of plant nutrients. It has poor tilth, chiefly because most of the thin surface layer has been removed and the dense, blocky clay subsoil has been exposed. Much of the soil is gullied. Runoff concentrates in the gullied areas, thereby increasing the erosion hazard. Ordinarily, the soil soaks up only small amounts of rainfall. The principal management problems are controlling erosion, conserving moisture, and improving tilth.

Wheat is the chief crop. Sudangrass, barley, and grain sorghum are also grown, but less extensively.

If the soil is cultivated, a complete terrace system should be installed to help to control water erosion. A soil-improving crop, such as hubam sweetclover, should be grown about a fifth of the time and a high-residue crop the rest of the time. Fertilizer applications should be based on soil tests and crop requirements.

This soil is suitable for irrigation, but water is not now available.

### **Capability unit IVe-2, dry-farmed**

This unit consists of a reddish-brown to brown, deep, sloping soil that is medium textured throughout. The soil is—

Enterprise very fine sandy loam, 5 to 8 percent slopes.

This fertile soil is readily permeable to water and plant roots. It is highly susceptible to water erosion because of slope. It is slightly susceptible to wind erosion during droughts. The principal management problems are controlling erosion, conserving moisture, and improving the organic-matter content. Wheat is the chief cash crop, but much of the acreage is in range.

If this soil is cultivated, a complete terrace system should be installed and all farming operations should be on the contour to help to control water erosion. A soil-improving crop, such as alfalfa or vetch, should be grown about a fifth of the time to maintain the organic-matter content of the soil and to improve its physical condition. A drilled high-residue crop should be grown the rest of the time. The residues, if properly managed, will help to control both wind and water erosion and help to maintain the organic-matter content. Fertilizer applications should be based on soil tests and on crop requirements.

This soil is suitable for irrigation, but water is not now available.

### **Capability unit IVe-3, dry-farmed**

This unit consists of a reddish-brown, deep, moderately sloping, moderately coarse textured soil that has a moderately fine textured subsoil. The soil is—

Miles fine sandy loam, 2 to 5 percent slopes, eroded.

This soil is moderately permeable to water and plant roots. It is moderately susceptible to water erosion, chiefly because of the concentration of runoff and the moderate slope. During droughts, the risk of wind erosion is moderate. The natural fertility is moderately low. The principal management problems are controlling erosion, increasing fertility, and conserving moisture. Cotton, grain sorghum, and sudangrass are the chief crops.

If this soil is cultivated, a soil-improving crop, such as alfalfa, guar, mung beans, or winter peas, should be grown about a fifth of the time, and a drilled high-residue crop the rest of the time. If properly managed, the residues will help to control erosion and to maintain fertility. Installing a complete terrace system and farming on the contour will help to control water erosion. Fertilizer applications should be based on soil tests and on crop requirements.

### **Capability unit IVe-4, dry farmed; IVe-1, irrigated**

This unit consists of reddish-brown to brown, deep, nearly level to gently sloping, coarse-textured soils that have a moderately coarse textured subsoil. The soils are—

Lincoln loamy fine sand.

Springer loamy fine sand, undulating.

Water moves freely through these soils. The natural fertility is very low. The Lincoln soil is more easily leached of plant nutrients than the Springer soil. Both soils are highly susceptible to wind erosion. At times, it is extremely difficult to prepare a good seedbed because the loose sands shift about so much. The principal manage-

ment problems are controlling erosion, conserving moisture, and increasing fertility.

Cotton, alfalfa, and grain sorghum are the chief crops. Most farmers grow alfalfa for hay and as a soil-improving crop.

If these soils are dry-farmed, a soil-improving crop, such as alfalfa or vetch, should be grown about a third of the time to help to maintain the organic-matter content and to improve the physical condition of the soil. A high-residue crop, such as grain sorghum or small grain, should be grown the rest of the time. If properly managed, the residues will help to control wind erosion and to maintain the organic-matter content. The surface of these soils should be kept rough and cloddy during the critical erosion periods. Applications of fertilizer should be based on soil tests and crop requirements.

If the soils are irrigated, a soil-improving crop should be grown 1 year in every 2 years. Commercial fertilizer is necessary to maintain high yields. Applications should be based on soil tests and crop requirements.

### **Capability unit IVe-5, dry-farmed**

This unit consists of a reddish-brown to brown, deep, moderately sloping, coarse-textured soil that has a moderately fine textured subsoil. The soil is—

Miles loamy fine sand, 3 to 5 percent slopes.

This soil is moderately permeable to water and plant roots. It is highly susceptible to wind erosion and moderately susceptible to water erosion, especially during rains of high intensity. The natural fertility is low. The principal management problems are controlling erosion, increasing fertility, and improving the physical condition of the soil. Sudangrass and grain sorghum are the chief crops.

If the soil is cultivated, alfalfa or vetch should be grown about a third of the time as a soil-improving crop to help to maintain the organic-matter content and to improve the physical condition. A drilled high-residue crop should be grown the rest of the time to help to control both wind and water erosion. Fertilizer applications should be based on soil tests and crop requirements.

This soil is suitable for irrigation, but water is not now available.

### **Capability unit IVe-6, dry-farmed**

This unit consists of reddish-brown to brown, shallow, well-drained, gently sloping to moderately sloping, medium-textured soils that have a moderately fine textured subsoil. The soils are—

Cobb fine sandy loam, shallow variant.  
Mansker loam, 3 to 5 percent slopes.

These soils are too shallow to permit the storage of a large amount of water. They are moderately susceptible to both wind erosion and water erosion. The natural fertility is low. The principal management problems are conserving moisture, controlling erosion, increasing fertility, and improving the physical condition of the soil. Sudangrass and small grains are the chief crops.

If the soils are cultivated, they should be farmed on the contour and a complete terrace system should be installed to help to control water erosion. A high-residue crop, such as a small grain or grain sorghum, should be grown continuously. The residues, if properly managed, will

help to maintain the organic-matter content and to improve the physical condition of the soil. Fertilizer applications should be based on soil tests and crop requirements. These soils are suitable for irrigation, but water is not now available.

#### **Capability unit Vw-1**

This unit consists of reddish-brown to dark-brown, deep, frequently flooded, poorly drained, saline soils on bottom lands. The soils are—

Loamy alluvial land.  
Sandy alluvial land.

These soils receive runoff from the surrounding, higher lying soils. They are subject to the hazards of flooding and scouring and to the deposition of fresh materials. Saline spots occur throughout. Consequently, the soils are not suitable for cultivation but should remain in range. The proper range management for these soils is discussed under "Bottom Land range site."

#### **Capability unit VIe-1**

This unit consists of reddish-brown to brown, sloping, medium-textured and moderately coarse textured soils that have a medium-textured to moderately coarse textured subsoil. The soils are—

Mansker loam, 5 to 8 percent slopes.  
Miles fine sandy loam, 5 to 8 percent slopes.  
Rough broken land, loamy.

These soils are not suitable for cultivation, chiefly because of their steep slopes. They are highly susceptible to water erosion and moderately susceptible to wind erosion. Although they support a fair cover of native grasses, careful management is required to prevent erosion. Their use for range and the proper management measures are discussed under "Mixed Land range site."

#### **Capability unit VIe-2**

This unit consists of a reddish-brown to brown, deep, well-drained, hummocky, coarse-textured soil that has a moderately coarse textured subsoil. The soil is—

Springer loamy fine sand, hummocky.

Because of its high susceptibility to wind erosion and its steep slopes, this soil is not suitable for cultivation. Its best use is range. Even if the soil has a fair cover of native grasses, careful management is required to prevent erosion. The proper range management is given under "Sandy Land range site."

#### **Capability unit VIe-3**

This unit consists of reddish-brown, shallow and very shallow, moderately fine textured soils. The soils are—

Vernon clay loam, 2 to 5 percent slopes.  
Vernon complex.

These soils are too shallow and steep for any cultivation. They are droughty and highly susceptible to water erosion. Their best use is range. Careful management of the native grasses is required to prevent erosion. The proper range management for these soils is given under "Shallow Hardland range site."

#### **Capability unit VIIe-1**

This unit consists of a brown, deep, moderately sloping to steeply sloping, sandy soil. The soil is—

Tivoli fine sand.

This soil is not suitable for cultivation, because it is highly susceptible to wind erosion, has low natural fertility, and consists mostly of large subdued dunes. Its best use is range. The sand dunes will become active again if the native grasses are overgrazed. The proper range management for this soil is given under "Sandy Land range site."

#### **Capability unit VIIIs-1**

This unit consists of moderately sloping to steeply sloping, raw, clayey soil materials in which there is little or no soil development. These miscellaneous land types are—

Oil-waste land.  
Rough broken land, clayey.

These land types are of very limited use for grazing. The steep slopes and deeply dissected gullies of Rough broken land, clayey, support very little vegetation. Oil-waste land is not so steep and eroded as Rough broken land, clayey, but most of it has no plant cover. The few areas of these land types that can be reclaimed and reseeded should be used for range and carefully managed. The proper range management is given under "Rough Breaks range site."

### **General Management Practices for Cropland**

The chief hazards to farming the soils in Wilbarger County result from the low average rainfall, occasional droughts, some rains of high intensity when much of the water runs off and is not taken in by the soil, and high winds. The purposes of management then are to conserve moisture, to protect the soils against both wind erosion and water erosion, to improve the physical condition of the soils, and to maintain productivity.

The loss of even a small amount of the surface soil reduces the supply of organic matter and plant nutrients in the soil and lessens its capacity to absorb and hold moisture. As a consequence, during heavy rains more water runs off and more soil is lost. The supply of water available to plants is further reduced.

It is difficult to distinguish between the damage done by water erosion and that done by wind erosion on the fine-textured soils. There are, however, about 120,000 acres of deep, coarse-textured, or sandy, soils in the county, which are especially subject to blowing. In many places, the silt and clay particles have been blown away and only sand remains.

Many of the practices needed to improve the soils and to protect them against erosion are common to all the soils. These general practices are discussed in the following paragraphs. Their specific application to the capability units is pointed out in the preceding subsection "Management by Capability Units."

*Using crop residues.*—Crop residues can be used to improve the soils and to protect them against erosion by both water and wind. Crop residues should not be burned. If

they are returned to the soil, they supply organic matter that increases fertility, improves tilth, helps to maintain soil structure, and keeps the soil porous and open. If left on the surface during critical erosion periods, they protect the soil against blowing and aid in the absorption and retention of rainfall. Fall, winter, and early spring are the critical erosion periods in this county. Crop residues also cut down the amount of soil lost by washing, since they slow down the rate of runoff. Crops grown in this county that produce a large amount of residue are small grains, grain sorghum, sudangrass, winter peas, vetch, and various clovers.

*Stubble mulching.*—This is primarily a protective practice. Stubble mulching is a year-round way of managing plant residues on cropland. Harvesting, seedbed preparation, planting, and cultivation are all done so as to leave residues of the previous crop on the soil until the next crop has been seeded. These residues, or stubble, make a mulch that helps to conserve soil and moisture. In Wilbarger County, the principal crops stubble mulched are wheat or other small grains, grain sorghum, and sudangrass.

*Using cover crops.*—This practice consists of growing close-growing grasses, legumes, and small grains, or erosion-resisting crops, as a protective plant cover in periods when the major crops do not furnish adequate cover to the soil. Cover crops ordinarily are on the land for 1 year or less. These crops also help to supply organic matter to the soil and to improve its physical condition.

*Stripcropping.*—This protective practice consists of growing crops in alternate bands or strips. In one band are close-growing crops that serve as a protective barrier against erosion and produce a large amount of residue. In the other band is a row crop or fallow land. To protect against water erosion, the strips should be on the contour. To protect against blowing, they should be at right angles to the prevailing wind.

*Conservation cropping systems.*—A good cropping system provides enough high-residue crops and other protective crops to control erosion. It also includes soil-improving crops that help to keep the soil in good physical condition and at a reasonable level of fertility. The principal soil-improving crops grown in the county are legumes and perennial grasses. Other high-residue crops, such as small grains, grain sorghum, forage sorghum, and sudangrass, are soil-improving crops if they are used in any one of the following ways: (1) The crop is fertilized and the residues are returned to the soil; (2) the residues are fertilized and the residues are returned to the soil; or (3) the crop is incorporated into the soil as a green-manure crop.

*Terraces and contour farming.*—A terrace consists of a channel and a ridge built across the slope. In this county, terraces are used both to conserve moisture and to control erosion. Contour farming consists of plowing, planting, and tilling across the slope. Furrows that run across the slope will slow down or stop the movement of water (fig. 12). Rainwater can then soak into the soil and be available to plants. Water erosion will also be reduced. In terraced fields, the furrows should be parallel to the terraces.

*Grassed waterways.*—Grassed waterways are designed to carry away runoff that would otherwise collect in natural drainageways, behind terraces, or in drainage and



Figure 12.—Contour-farmed field after a rain of 2 inches that fell in 1 hour.

irrigation systems. They consist of broad, grass-covered, flat-bottomed channels built at such a grade that runoff water does not erode the soil. Proper maintenance is required.

*Deep plowing.*—This practice is widely used in Wilbarger County on the highly erodible loamy fine sands that have a sandy clay loam subsoil. By plowing to a depth of 16 to 24 inches, from 4 to 8 inches of the sandy clay loam subsoil is brought to the surface. When this finer textured material is mixed with the sandy surface soil, the texture of the plow layer is fine sandy loam. The soil can then be roughened by listing or chiseling and formed into clods that are resistant to the wind. In some places, yields have increased as much as 50 percent in the first year or two after deep plowing. Benefits from deep plowing will last only a few years, however, unless coddiness, roughness, and fertility are maintained. Crop residues should be left on the surface during critical erosion periods, and manure and legumes should be used to help to maintain fertility and good physical condition.

*Use of fertilizers.*—Many of the soils in the county require applications of commercial fertilizer for high crop yields. Crops grown on the moderately coarse textured and coarse textured soils respond quickly to fertilization and to the moisture supplied in small showers. Crops grown on the medium-textured soils respond to fertilization in seasons of high rainfall. Crops grown on the moderately fine textured and fine textured soils are less responsive, if at all, to fertilizer if they are dry-farmed. Most of the soils need to be fertilized for sustained high production if they are irrigated. The kind and amount of fertilizer to be applied should be determined by soil tests. Up-to-date information on soil sampling and testing and on fertilizer applications can be obtained from the local county agent or from technicians of the Soil Conservation Service.

*Pasture planting.*—Many acres of cultivated land in the county are best suited to pasture because of steep slope, shallowness of the soil, and unstable, shifting sands. They are highly susceptible to erosion, and a permanent cover of native grasses is the best means of control. Pastures can be established by either seeding or sprigging proved varieties of suited grasses and legumes. Up-to-date information on suitable varieties and methods of estab-

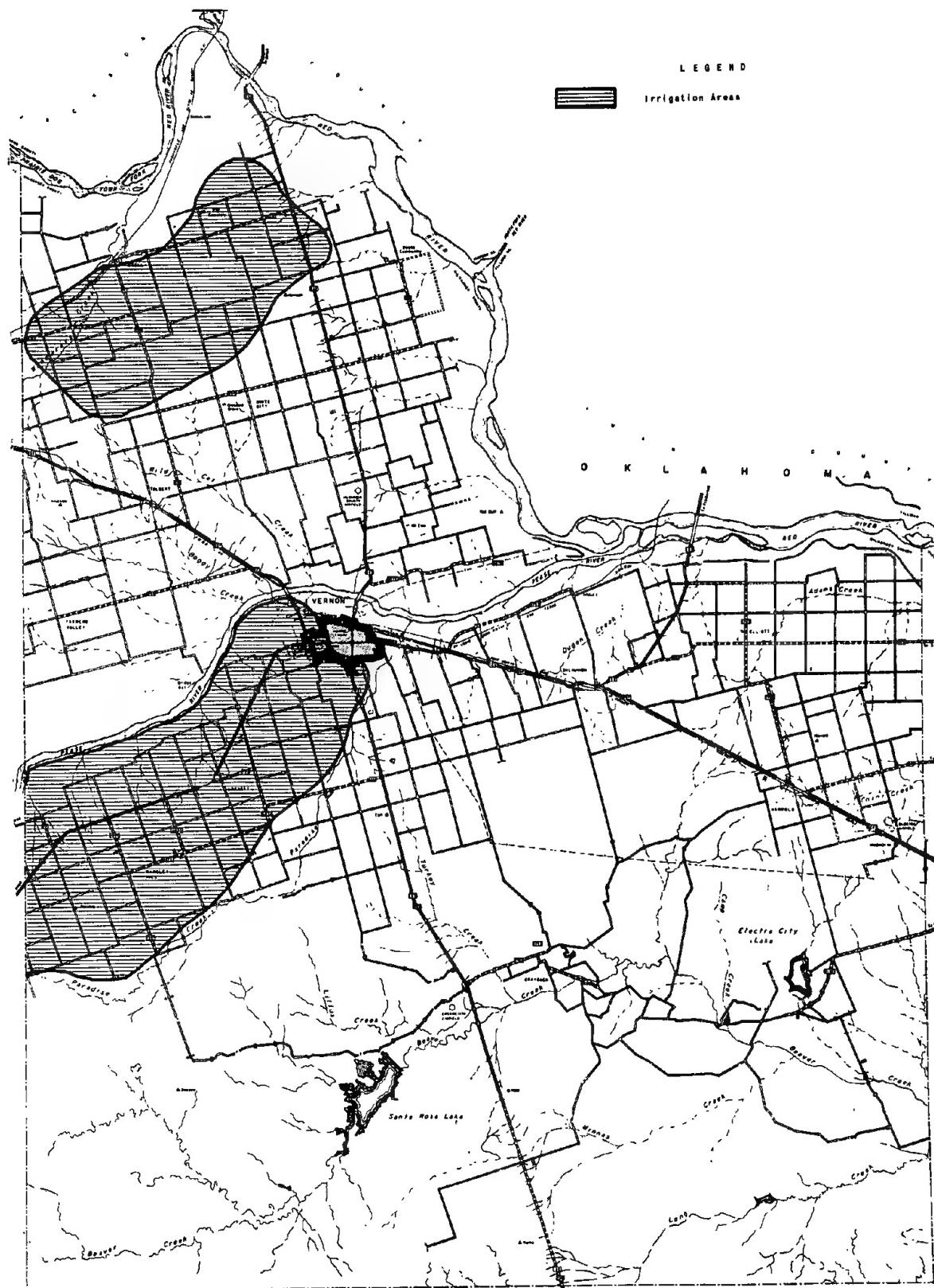


Figure 13.—Irrigation areas in Wilbarger County.



**Figure 14.**—Row irrigation on Tipton silt loam. Cotton yields on this irrigated field averaged well over 1½ bales per acre.

lishment can be obtained from the local county agent or from technicians of the Soil Conservation Service.

## Irrigation

Irrigation is a fairly new practice in Wilbarger County. There were only a few irrigation wells in the county before 1955. Since that time about 130 wells have been drilled, and approximately 6,000 acres are irrigated at least part of the time.

Many of the soils are suitable for irrigation, but water is not everywhere available. Two areas in the northwestern part of the county have underground water in sufficient amounts to be used for irrigation (fig. 13). Here, wells have been sunk into the beds of alluvial sandy clays, sands, and gravels of the Seymour formation, which overlies the uneven surface of the Permian red beds (10). These wells vary in production, the amounts ranging from 100 to 650 gallons per minute.

Two kinds of irrigation systems are used—row and sprinkler. Row irrigation is used on the nearly level, medium textured and moderately fine textured soils (fig. 14). In some places it is necessary to further level the soils before row irrigation can be used. Sprinkler irrigation works well on most slopes and is especially well suited to the deep, sandy soils southwest and north of Vernon (fig. 15). Conservation irrigation, which makes possible irrigation without erosion damage, accumulation of alkali, waterlogging, or undue loss of water, can be accomplished by either method.

At the present time, irrigation is a supplemental practice, used chiefly in periods of drought. Generally, crop yields are doubled in those fields that have been irrigated. Since irrigation is new and is used to only a minor extent in the county, data on yields have not been collected.

## Estimated Yields of Crops

Yields of crops depend chiefly on the tilth and fertility of the soils and on a sufficient supply of moisture at the time of planting and throughout the growing season.

Lack of moisture commonly is the limiting factor in Wilbarger County. Consistent high yields on any soil indicate that the soil has been well managed; that is, fertility has been kept at a high level, good tilth has been maintained, and rainwater has been held and stored in the soil. On the other hand, consistent low yields indicate that the soil has not been well managed; that is, it has not been protected against the loss of soil and water, and measures have not been taken to improve fertility and tilth.

Table 2 gives estimated average acre yields for three major crops—cotton, wheat, and alfalfa—under a low level of management and under a high level of management. The characteristics of the two levels of management are described in the following list.

- A. Low-level management.
  - 1. Soil-improving crops, cover crops, and high-residue crops are not used in the rotations.
  - 2. Crop residues are destroyed or turned under quickly.
  - 3. Water is only partially conserved.
  - 4. Fertilizer is not used.
  - 5. Tillage alone is depended on to control wind erosion.
- B. High-level management.
  - 1. Soil-improving crops, cover crops, and high-residue crops are used in the rotations.
  - 2. Crop residues are kept on the surface to help to control wind erosion.
  - 3. Water is conserved by using all necessary practices, including terracing and contour farming.
  - 4. Fertilizer is applied according to crop requirements and soil tests.

The estimates were prepared by interviewing farmers and studying experiment station records. Yields of alfalfa hay on a particular soil vary widely from farm to farm, chiefly because of differences in the supply of water. Where there is a high water table, the yields are increased by about one-half ton per acre. Estimates are not given for one or more of these three major crops for some soils; these soils are not suited to the crops. Limited amounts of sudangrass, sorghum, and guar are produced on these soils.



**Figure 15.**—Sprinkler irrigation on Miles loamy fine sand. Despite a wind of 25 miles per hour, the system was in full operation because of the protection afforded by a windbreak. An unprotected cottonfield on the same kind of soil, one-half mile south of this field, was severely damaged by erosion caused by this same wind.

TABLE 2.—Estimated average acre yields of three major crops under two levels of management

[Yields in columns A are those obtained under low-level management; yields in columns B are those obtained under high-level management (see text). Blank spaces indicate that the crop is not ordinarily grown on the soil]

Soil	Cotton lint		Wheat		Alfalfa		Soil	Cotton lint		Wheat		Alfalfa			
	A	B	A	B	A	B		A	B	A	B	A	B		
	Pounds	Pounds	Bushels	Bushels	Tons	Tons	Pounds	Pounds	Bushels	Bushels	Tons	Tons	Pounds	Pounds	
Abilene clay loam, 0 to 1 percent slopes	150	175	15	19	—	—	Miles fine sandy loam, 2 to 5 percent slopes, eroded	110	130	—	—	—	—	—	—
Abilene clay loam, 1 to 3 percent slopes	125	160	13	16	—	—	Miles fine sandy loam, 5 to 8 percent slopes	—	—	—	—	—	—	—	—
Abilene-slickspot complex	—	—	7	9	—	—	Miles loamy fine sand, 0 to 3 percent slopes	125	250	—	—	3.0	4.5	—	—
Altus fine sandy loam	325	375	24	30	3.5	4.0	Miles loamy fine sand, 3 to 5 percent slopes	—	—	—	—	—	—	—	—
Altus fine sandy loam, poorly drained variant	—	—	8	10	—	—	Miller clay	—	—	—	—	—	—	—	—
Altus loamy fine sand	275	350	—	—	4.5	5.0	Miller clay loam	—	—	14	18	—	—	—	—
Cobb fine sandy loam, 1 to 3 percent slopes	125	160	10	12	—	—	Norwood clay loam	175	225	16	20	—	—	—	—
Cobb fine sandy loam, shallow variant	100	120	—	—	—	—	Norwood silt loam	315	360	22	28	3.5	4.0	—	—
Enterprise fine sandy loam, 0 to 1 percent slopes	180	230	—	—	2.0	2.5	Oil-waste land	—	—	—	—	—	—	—	—
Enterprise fine sandy loam, 1 to 3 percent slopes	165	210	—	—	2.0	2.5	Port clay loam	200	250	22	30	—	—	—	—
Enterprise very fine sandy loam, 0 to 1 percent slopes	325	375	20	30	1.0	1.5	Rough broken land, clayey	—	—	—	—	—	—	—	—
Enterprise very fine sandy loam, 1 to 3 percent slopes	175	250	18	25	1.0	1.5	Rough broken land, loamy	—	—	—	—	—	—	—	—
Enterprise very fine sandy loam, 3 to 5 percent slopes	165	200	12	15	—	—	Sandy alluvial land	—	—	—	—	—	—	—	—
Enterprise very fine sandy loam, 5 to 8 percent slopes	—	—	10	12	—	—	Springer loamy fine sand, hummocky	—	—	—	—	—	—	—	—
Hollister clay loam, 0 to 1 percent slopes	130	155	13	15	—	—	Springer loamy fine sand, undulating	125	200	—	—	2.5	4.0	—	—
Hollister clay loam, 1 to 3 percent slopes	120	145	11	13	—	—	Tillman clay loam, 0 to 1 percent slopes	125	140	11	13	—	—	—	—
Lincoln loamy fine sand	100	125	—	—	—	—	Tillman clay loam, 1 to 3 percent slopes	115	130	10	12	—	—	—	—
Loamy alluvial land	—	—	—	—	—	—	Tillman clay loam, 1 to 3 percent slopes, eroded	—	—	8	10	—	—	—	—
Mansker loam, 1 to 3 percent slopes	—	—	10	12	—	—	Tipton silt loam, 0 to 1 percent slopes	325	375	22	30	2.0	2.5	—	—
Mansker loam, 3 to 5 percent slopes	—	—	9	10	—	—	Tipton silt loam, 1 to 3 percent slopes	275	350	18	24	2.0	2.5	—	—
Mansker loam, 5 to 8 percent slopes	—	—	—	—	—	—	Tivoli fine sand	—	—	—	—	—	—	—	—
Miles fine sandy loam, 0 to 1 percent slopes	—	—	—	—	—	—	Vernon clay loam, 2 to 5 percent slopes	—	—	6	8	—	—	—	—
Miles fine sandy loam, 1 to 3 percent slopes	200	250	17	22	2.0	2.5	—	—	—	—	—	—	—	—	
Miles fine sandy loam, 3 to 5 percent slopes	175	225	16	20	2.0	2.5	Wichita clay loam, 0 to 1 percent slopes	125	160	13	15	—	—	—	—
Miles fine sandy loam, 5 to 8 percent slopes	140	160	—	—	—	—	Wichita clay loam, 1 to 3 percent slopes	120	140	11	13	—	—	—	—

## Management of the Soils for Range<sup>2</sup>

The current use of the native grassland in Wilbarger County, the range sites and range conditions, and the general practices of management appropriate for most rangeland are discussed in this section.

### Current use of grassland

Native grassland amounts to about 315,000 acres, or about 55 percent of the agricultural land in the county. Livestock raising is a major industry. Cows and calves are the chief livestock, along with some winter stockers, or carry-over calves, which graze the wheatland. Almost all the ranches include some cropland that is used for supplemental grazing. The chief crops used for temporary grazing are small grains, sudangrass, and johnsongrass.

<sup>2</sup>This subsection was prepared by ODIS J. CURRY, range conservationist, Soil Conservation Service.

Since the forage produced on rangeland is marketed through the sale of livestock and livestock products, the success of the livestock enterprise depends on the way the ranchers manage their grassland.

The native grass cover over most of the county consists of a mixture of mid and short grasses. The hardlands in the southern part of the county are covered by side-oats grama, blue grama, and buffalograss. On the rough, broken, steep lands west and southwest of Vernon, side-oats grama is the chief grass, but little bluestem grows on some of the slopes with northern and northeastern exposures, which have more favorable growing conditions. On the sandy lands along the Red River in the northern and northwestern part of the county, the grass cover is a community of tall and mid grasses, such as Indiangrass, switchgrass, sand bluestem, Canada wildrye, and little bluestem.

About 70 percent of the grassland is in fair or poor condition. Because they have been overused for a long time,

the hardlands are now covered mostly by buffalograss and Texas wintergrass, in which there is a heavy infestation of mesquite trees. Sand sagebrush is rapidly invading the overused sandy lands, and saltcedar, the bottom lands. It is estimated that saltcedar is now growing on 20,000 acres along the intermittent streams in the county.

The climate of the county, which is one of extremes, has a marked influence on the production of forage. Rainfall is erratically distributed; most of it occurs in four months—May, June, September, and October. Many of the rains in these months are of high intensity and result in excessive runoff, but some are ineffective showers. Droughts, which are common in midsummer and may last from 30 to 90 days, retard plant growth and prevent the spread of range vegetation. The hot, high winds make for excessive evaporation and transpiration.

Native grasses grow best from the middle of April to October, but the recurrent droughts result in some dormancy in July and August almost every year. If enough moisture is available, the grasses start growing again about the first of September and continue to grow until the middle of October, when they again become semidormant because of the cool weather. Frequently, early growth is retarded by the lack of moisture in winter and early in spring.

#### **Range sites and condition classes**

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. The soils that will produce about the same kind and amount of forage if the ranges are in similar condition make up what is called a range site.

Range sites are kinds of rangeland that differ from each other in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. *Climax vegetation* is the stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment remains unchanged. Throughout most of the prairie and the plains, the climax vegetation consists of the plants that were growing there when the region was first settled. If cultivated crops are not to be grown, the most productive combination of forage plants on a range site is generally the climax type of vegetation.

*Decreasers* are species in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

*Increases* are species in the climax that increase in relative amount as the more desirable plants are reduced by close grazing. They are commonly shorter and some are less palatable to livestock than decreasers.

*Invaders* are plants that cannot withstand the competition for moisture, nutrients, and light in the climax vegetation. Hence, they come in and grow along with the increasers after the climax vegetation has been reduced by grazing. Many are annual weeds; some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the native, or climax, vegetation brought about by grazing or other use. The classes show the present condition of the native vegetation on a range

site in relation to the native vegetation that could grow there.

A range is in *excellent condition* if 76 to 100 percent of the vegetation is of the same kind as in the original stand. It is in *good condition* if the percentage is between 51 and 75, in *fair condition* if the percentage is between 26 and 50, and in *poor condition* if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular kind of range site. It expresses the present kind and amount of vegetation in relation to the climax for that site.

Potential forage production depends on the range site. Current forage production depends upon the range condition and the moisture that the plants get during their growing season.

One of the main objectives of good range management is to keep rangeland in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing important changes in the kind of cover on a range site. These take place gradually and can be misunderstood or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-time trend is toward lower production. On the other hand, some rangeland that has been closely grazed for relatively short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

#### **Descriptions of range sites**

In this subsection, the six range sites in Wilbarger County are described; the soils in each site are listed; and the composition of the climax vegetation is given, and the principal invaders are listed. The estimated yields of usable air-dry forage by the different range condition classes are given.

##### **BOTTOM LAND SITE**

This site consists of the lowlands along rivers, intermittent streams, and small draws. These lowlands are subject to overflow, and they also receive runoff from higher lying soils. Although flooded frequently, they are under water for only short periods. Any damage to vegetation, therefore, ordinarily is from sedimentation rather than from wetness. A typical area is at the Pease River bridge on U.S. Highway 287, 1 mile northwest of Vernon.

The soils in this site are—

- Lincoln loamy fine sand.
- Loamy alluvial land.
- Miller clay.
- Miller clay loam.
- Norwood clay loam.
- Norwood silt loam.
- Port clay loam.
- Sandy alluvial land.
- Yahola very fine sandy loam.

These soils are deep and fertile. They range in permeability from very slow to moderately rapid. Because of the extra moisture received from runoff, this is considered one of the better range sites. In dry periods, it may provide the only green forage on the range.

The composition of the climax vegetation varies from place to place, depending on the origin of the alluvial deposits. About 75 percent consists of climax decreasers—

big bluestem, sand bluestem, little bluestem, Indiangrass, switchgrass, Canada wildrye, side-oats grama, plains bristlegrass, and cottontop. Climax increasers are Texas wintergrass, tobosa, western wheatgrass, vine-mesquite, silver bluestem, blue grama, buffalograss, white tridens, meadow dropseed, and, in alkali spots, alkali sacaton. A few woody plants, chiefly elm, hackberry, and cottonwood, occur in the climax vegetation on some of the bottom lands.

If the climax vegetation is not maintained, the site is invaded by noxious plants that develop from seed washed in from large outlying areas. These invaders, ordinarily annuals common in cultivated fields, include sunflower, cocklebur, woolly tidesstromia, buffalo-bur, hairy caltrop, camphorweed, common broomweed, crotons, thistles, and sandbur. Other common invaders are sand dropseed, three-awn, windmillgrass, Texas grama, hairy tridens, inland saltgrass in saline areas, and perennial forbs. The principal woody invaders are saltcedar, mesquite, lotebush, tasajillo, and pricklypear.

This site is capable of high production if it is not overwashed by shale or clay sediments. In average years, the estimated yield of usable air-dry forage per acre is 3,500 pounds if the range is in excellent condition; 2,500 pounds, in good condition; 1,500 pounds, in fair condition; and 1,000 pounds, in poor condition.

#### SANDY LAND SITE

This site occurs mostly southwest of Vernon and in the northern part of the county. The topography ranges from smooth and nearly level to sloping and rolling. A typical area is on U.S. Highway 283 immediately south of the Red River bridge, 22 miles north of Vernon.

The soils in this site are—

- Altus loamy fine sand.
- Miles loamy fine sand, 0 to 3 percent slopes.
- Miles loamy fine sand, 3 to 5 percent slopes.
- Springer loamy fine sand, hummocky.
- Springer loamy fine sand, undulating.
- Tivoli fine sand.

These soils are deep, coarse textured, and moderately to rapidly permeable to water and roots. They have a low capacity, however, for holding water and plant nutrients. If not protected, they are highly susceptible to wind erosion. If properly managed, they will produce a good stand of mid and tall grasses.

About 75 percent of the plant community on this site consists of climax decreasers—sand bluestem, switchgrass, Indiangrass, little bluestem, Canada wildrye, sand lovegrass, side-oats grama, and plains bristlegrass. Approximately 25 percent of the plants are climax increasers—silver bluestem, sand dropseed, hairy grama, blue grama, and perennial three-awn. On some of the soils in this site, a few woody plants, such as shinnery oak, plum sagebrush, and sand sagebrush, were present in the climax vegetation.

Any deterioration in this site results in a rapid increase in woody plants. As deterioration continues, woody plants, such as small soapweed (*yucca*), almost completely replace the better grasses by shading them and by using all the available moisture. Invading grasses include annual three-awn, fringed signalgrass, tumble windmillgrass, gummy lovegrass, red lovegrass, tumble lovegrass, low-growing paspalums, and purple sandgrass. The chief invading forbs are showy partridgepea, Texas sleepdaisy,

common ragweed, dozedaisy, wax goldenweed, tumble ringwing, annual wild-buckwheat, rosering gaillardia, prairie sunflower, woollywhite, bee balm, pricklepoppies, curlycup gumweed, camphorweed, sandlily, Riddell groundsel, and stillingia.

This site is capable of high production if it is maintained in good or excellent condition. Since there are few grasses of intermediate value for grazing, production drops rapidly once the climax vegetation is overgrazed. Recovery is rapid, however, if brush is controlled and grazing deferred, since there is usually a source of seed present. In average years, the estimated yield of usable air-dry forage per acre is 3,000 pounds if the range is in excellent condition; 2,500 pounds, in good condition; 1,500 pounds, in fair condition; and 1,000 pounds, in poor condition.

#### DEEP HARDLAND SITE

This site consists mostly of smooth, nearly level to gently sloping upland plains in the southern part of the county. It is commonly associated with the Shallow Hardland site, which occurs on ridges at a higher elevation. Where these sites are intermingled, they form a rolling terrain. The Deep Hardland site is readily accessible to livestock and is a favorite site for grazing. A typical area is on a ranch 4 miles west of Vernon.

The soils in this site are—

- Abilene clay loam, 0 to 1 percent slopes.
- Abilene clay loam, 1 to 3 percent slopes.
- Abilene-slickspot complex.
- Hollister clay loam, 0 to 1 percent slopes.
- Hollister clay loam, 1 to 3 percent slopes.
- Tillman clay loam, 0 to 1 percent slopes.
- Tillman clay loam, 1 to 3 percent slopes.
- Tillman clay loam, 1 to 3 percent slopes, eroded.
- Wichita clay loam, 0 to 1 percent slopes.
- Wichita clay loam, 1 to 3 percent slopes.

These soils are moderately fine textured and more than 20 inches deep. They are only moderately to slowly permeable to water and roots, but they have a high capacity to hold both water and plant nutrients. In many places, the intake of moisture is further reduced by surface crusting and by the compacted layer, or "hoof pan," caused by trampling. If these soils are not protected, water erosion becomes a problem.

The climax vegetation on this site consists of mid and short grasses. About 60 percent consists of decreasers—side-oats grama, blue grama, and cottontop. Plains bristlegrass occurs to a limited extent, and western wheatgrass and vine-mesquite grow in depressions. Little bluestem ordinarily does not grow on this site, except on areas containing gypsum or on gravelly or rocky soils that may be included. Climax increasers make up about 40 percent of the climax vegetation. Important species are buffalograss, Texas wintergrass, silver bluestem, tobosa, and, in saline spots, alkali sacaton. Meadow dropseed and white tridens are common increasers along small drains and around depressions.

Continuous overgrazing results in an immediate decrease in side-oats grama, followed by a decrease in blue grama. Buffalograss and tobosa then increase. Further degeneration of the range results in invasion by perennial three-awn, hairy tridens, sand dropseed, Texas grama, tumblegrass, pricklypear, mesquite trees, lotebush, and numerous annuals. Large areas of range in poor condition are bare. In years in which there is a wet spring, in-

vading annuals will occupy these bare spots. The most common of these are Texas filaree, evax, various plantains, bladderpod, plains greenthread, bitterweed actinea, snow-on-the-mountain, common broomweed, little barley, and Japanese brome. The common invading perennial forbs on this site are western ragweed, onion, silverleaf nightshade, cutleaf germander, and Dakota verbena.

This site is capable of only limited production. A large amount of litter and cover is necessary to reduce surface crusting and to prevent erosion. Once the range is in poor condition, recovery is very slow because of the lack of seed plants of desirable climax species, the crusted soils, and the heavy infestation by mesquite. In average years, the estimated yield of usable air-dry forage per acre is 1,750 pounds, if the range is in excellent condition; 1,250 pounds, in good condition; 500 pounds, in fair condition; and 250 pounds, in poor condition.

#### MIXED LAND SITE

This site occurs on nearly level to gently rolling uplands throughout the county. A typical area is on a farm 2½ miles southeast of Wilbarger County courthouse.

The soils in this site are—

- Altus fine sandy loam.
- Altus fine sandy loam, poorly drained variant.
- Cobb fine sandy loam, 1 to 3 percent slopes.
- Cobb fine sandy loam, shallow variant.
- Enterprise fine sandy loam, 0 to 1 percent slopes.
- Enterprise fine sandy loam, 1 to 3 percent slopes.
- Enterprise very fine sandy loam, 0 to 1 percent slopes.
- Enterprise very fine sandy loam, 1 to 3 percent slopes.
- Enterprise very fine sandy loam, 3 to 5 percent slopes.
- Enterprise very fine sandy loam, 5 to 8 percent slopes.
- Mansker loam, 1 to 3 percent slopes.
- Mansker loam, 3 to 5 percent slopes.
- Mansker loam, 5 to 8 percent slopes.
- Miles fine sandy loam, 0 to 1 percent slopes.
- Miles fine sandy loam, 1 to 3 percent slopes.
- Miles fine sandy loam, 3 to 5 percent slopes.
- Miles fine sandy loam, 2 to 5 percent slopes, eroded.
- Miles fine sandy loam, 5 to 8 percent slopes.
- Rough broken land, loamy.
- Tipton silt loam, 0 to 1 percent slopes.
- Tipton silt loam, 1 to 3 percent slopes.
- Wichita loam, 0 to 1 percent slopes.

These shallow to deep soils are medium textured and moderately coarse textured. Permeability ranges from moderate to moderately rapid, and the capacity to hold water is moderate. Deep U-shaped gullies are common in unprotected areas of Enterprise soils through which water moves fairly rapidly.

About 70 percent of the vegetation consists of climax decreasers. Side-oats grama is the dominant species. Other climax decreasers are little bluestem, cottontop, and plains bristlegrass, and, along the larger drains, Canada wildrye, switchgrass, and western wheatgrass. For the most part, little bluestem is confined to isolated areas that have more moisture, such as some of the shallow soils fed by springs and areas containing gypsum. Approximately 30 percent of the climax vegetation consists of increasers—blue grama, buffalograss, hairy grama, sand dropseed, silver bluestem, and, along drains, meadow dropseed.

Any deterioration in the vegetation results in an immediate decrease in side-oats grama, followed by an increase in blue grama and buffalograss. If continuously overgrazed, the range vegetation soon consists almost entirely of buffalograss and numerous invading forbs; blue

grama then is confined to protected areas. The chief invading grasses are red grama, Texas grama, sixweeks grama, Japanese brome, tumble windmillgrass, hooded windmillgrass, gummy lovegrass, little barley, tumblegrass, and hairy tridens. Invading forbs are the same as those that invade the Sandy Land site. Woody invaders are mesquite, pricklypear, tasajillo, and small soapweed.

This site is capable of moderate production of forage if it is in good or excellent condition. If adequate plant cover and litter are not maintained, the site deteriorates rapidly because of wind and water erosion. Recovery is slow because viable seeds of climax plants are lacking and, in some places, because of surface crusts on the soil. In average years, the estimated yield of usable air-dry forage per acre is 2,000 pounds if the site is in excellent condition; 1,500 pounds, in good condition; 1,000 pounds, in fair condition; and 500 pounds, in poor condition.

#### SHALLOW HARDLAND SITE

This site occurs on low, rolling hills and ridges. The site is closely associated with the Deep Hardland site and is mostly in the southern part of the county. Stones and gravel are common on the surface and throughout the soils. In some places, large rock ledges crop out. A typical area is on a ranch 2 miles south of Electra Lake in the southeastern part of the county.

The soils in this site are—

- Vernon clay loam, 2 to 5 percent slopes.
- Vernon complex.

These soils are moderately fine textured and moderately to very slowly permeable to water and plant roots. They are from 10 to 20 inches deep. They have a high water-holding capacity. A good plant cover is necessary to reduce evaporation and to control water erosion.

The climax vegetation consists mostly of mid and short grasses. Climax decreasers, of which side-oats grama is the dominant species, constitute about 65 percent of the plant community. Other important decreasers are blue grama and little bluestem. Sand bluestem and Indian-grass occur on some areas that have northern and eastern exposures. In these areas, the moisture conditions are more favorable because the soils contain some gravel or are influenced by some other factor. Forbs in the climax vegetation are ground plum milkvetch, dalea, prairie-clover, scurfpea, heath aster, engelmannia, dotted gayfeather, penstemon, sagewort, and gaura. These forbs are important indicators in determining trends in the condition of the range. Desert shrubs, such as acacia, mimosa, vine ephedra, agarita (laredo mahonia), and skunkbush, are present to a limited extent. Climax increasers make up about 35 percent of the climax vegetation. Important species are hairy grama, silver bluestem, buffalograss, perennial three-awn, and tobosa.

The chief woody invaders are mesquite, grassland croton (New Mexico croton), pricklypear, lotebush, and small soapweed. If there is a nearby source of seed, redberry juniper also invades this site. Common invading perennial grasses are hairy tridens, sand dropseed, Texas grama, red grama, and tumblegrass. The chief invading forbs are broom snakeweed, false-broomweed in spots containing gypsum, plains actinea, gray goldaster, wavyleaf thistle, hoary blackfoot, threadleaf groundsel, and Texas stillinia. Other common invading forbs are common broom-

weed, bitterweed *actinea*, oneseed croton, Texas filaree, evax, plantain, plains greenthread, and bladderpod.

Recovery of deteriorated ranges on this site ordinarily is good. Moisture conditions are more favorable than on some other sites, and the stones on the surface help to protect plants against overgrazing and permit seedlings to get established. In average years, the estimated yield of usable air-dry forage per acre is 1,500 pounds if the range is in excellent condition; 1,250 pounds, in good condition; 750 pounds, in fair condition; and 250 pounds, in poor condition.

#### ROUGH BREAKS SITE

This site consists mostly of steep escarpments and the severely eroded "scald" areas below the escarpments, which gives an overall appearance of rough breaks. Smooth, round pebbles commonly are scattered over the surface. In places, sandstone crops out as a ledge above the Permian clays. This site commonly is associated with areas of the Deep Hardland site, which occurs both above and below it. A typical area is at the east side of U.S. Highway 283, just north of the Pease River bridge, 1 mile north of Vernon.

The land types in this site are—

*Oil-waste land.*

*Rough broken land, clayey.*

The soil material in this site is variable. Much of it consists of calcareous, partially weathered Permian clays and shales, in which there is little or no soil development. On the whole, slopes are steep, runoff is high, and erosion is very severe. Oil wastes have accumulated on some areas in this site.

The plant cover on this site is highly variable because of differences in soil material, slope, exposure, and degree of geologic erosion. About 50 percent consists of climax decreasers, of which side-oats grama and blue grama are the dominant species. Sand bluestem and little bluestem grow in places where moisture conditions are favorable. Vine-mesquite grows in depressions and along small drains below the escarpments. Plains bristlegrass and cottontop are present to a limited extent. Tobosa is the dominant climax increaser, and much of the site is either bare or has some tobosa growing on it. Other climax increasers are hairy grama, buffalograss, silver bluestem, perennial threeawn, sand dropseed, and, in saline spots, alkali sacaton.

As the range deteriorates, a slick crust that prevents the infiltration of water forms over much of the surface. A relatively large amount of protective cover or litter is needed to correct this condition. Under prolonged overgrazing, the site is invaded by woody species, such as mesquite, tasajillo, lotebush, pricklypear, fourwing saltbush, and redberry juniper. Because the site is droughty, these woody invaders are shrubby and in thin stands. Other invaders are hairy tridens, Texas grama, red grama, annual forbs that grow in spring, and a few perennial forbs.

This site is capable of producing only a small amount of usable forage. Any deterioration in the range results in further erosion. The potential capacity of the site then is reduced to the point at which management must be based on increasing the subdominant species. Particular attention must be paid to protecting the areas with grass cover and litter. Ordinarily, recovery also requires reseeding and pitting or chiseling the soil or soil material. In average years, the estimated yield of usable air-dry forage per

acre is 750 pounds if the range is in excellent condition; 500 pounds, in good condition; 250 pounds, in fair condition; and 100 pounds, in poor condition.

#### Practices for rangeland

The basic purpose of good range management is to increase the number of the best native forage plants and to encourage their growth. The main practices needed to achieve this purpose are the following.

*Control of grazing.*—Without control of grazing, all other practices will fail. In their green leaves, grasses manufacture the food they need to grow, flower, and reproduce. If too much of this green foliage is removed by grazing or mowing, the plant is weakened and stunted.

Because livestock constantly seek out and graze the plants most palatable and nutritious, the less palatable plants and those that are low growing and matted tend to survive. For this reason, grazing is controlled so that the desirable grasses survive and are vigorous enough to compete successfully. Generally, the desirable plants will do this if no more than half their yearly growth is removed by grazing. The growth left on the ground does these things—

1. Serves as a mulch that encourages the intake and storage of water. The more water stored in the ground, the better the growth of grasses for grazing.
2. Allows roots to reach moisture deep in the soils. Overgrazed grass cannot do this because not enough green shoots are left to provide food for good root growth.
3. Protects the soil from wind and water erosion. Grass is the best cover for controlling erosion.
4. Allows the better grasses to crowd out weeds. When this happens, the range improves.
5. Enables grasses to store in their roots the food they need for quick, vigorous growth in spring and after droughts.
6. Provides a reserve of feed for dry spells that otherwise might force sale of livestock at a loss.

In stocking rangeland, the rancher needs to (1) know the range sites on his holdings; (2) identify the plants currently on each range site so he may determine whether it is in excellent, good, fair, or poor condition; (3) consider that at least half the growth in a year should be left on the land; (4) judge how much forage left on the ground may be removed by weathering, wind, rodents, or other causes; and (5) decide how soon it will be practical to restore depleted pasture by lowering the stocking rate.

After livestock are put on the land, the operator needs to observe the effect of grazing. If the key grasses on a range site are big bluestem, little bluestem, and switchgrass, are livestock cropping them too closely? Or if this site was in a lower condition when the cattle were put on it and the key forage plant for that condition is buffalograss, how much of it is being removed? The rancher may judge by comparing ungrazed plants of buffalograss with those grazed. If most of the buffalograss has been cropped down, it is time to remove all or part of the livestock.

Adjusting the stocking rate for a pasture so as to obtain the highest returns without lowering the production of native grasses requires skill and experience. The de-

scriptions of the individual range sites in the preceding section will be of value because they list, for each site, the plants on the site and the estimated yield of forage under the four range conditions. The experience of other ranchers on similar rangeland may be helpful in making the decisions. Also, the rancher may obtain assistance from local representatives of the Soil Conservation Service or other agencies.

*Deferred grazing.*—Rest in summer or early in fall is a good way to hasten the recovery of range that is in fair or poor condition. The desirable plants will then have an opportunity to grow vigorously, to spread vegetatively, and to produce seed. Not only does deferred grazing permit the recovery and improvement of the range, but it also builds up a reserve of forage for later use. A schedule of deferred grazing can be worked out by rotating grazing on different parts of the range. Fencing is required. The rest seasons should be adjusted to the growing and seeding habits of the key species.

*Fencing.*—Grazing can be more easily controlled or deferred by fencing. Cross fencing of large pastures provides for better distribution of grazing. Deferred grazing is more easily scheduled if several pastures are rotated. Since different range sites produce different kinds and amounts of forage, fences should be built as close as possible to the boundaries of the different range sites on a farm or ranch.

*Control of brush.*—Forage yields on depleted rangeland increase greatly, and livestock are more easily handled, if brush is removed or controlled. Many of the ranges in the Deep Hardland and Shallow Hardland sites are infested with mesquite. Those on depleted Sandy Land sites are infested with sand sagebrush. In Wilbarger County, both chemical sprays and mechanical methods are used to control brush.

*Range seeding.*—Seeding depleted cropland to perennial grasses has been highly successful and profitable in this county (fig. 16). Much of the cropland being converted to range consists of fields in which most of the surface soil has been removed by erosion. The soils have lost most of their natural fertility. Special measures must be taken to get a good stand and to protect the fields against further erosion while the grasses are being established. Ranges

in poor condition may need to be overseeded to improve production and to prevent loss of soil and water. Many of these ranges and converted crop fields need pitting or chiseling to increase the intake of water, and also some mechanical brush control. In this county, overseeding is done mostly on the Deep Hardland site and on the smoother areas of the Rough Breaks site.

*Providing water for livestock.*—Good management of grassland requires that livestock have an adequate supply of water of good quality at places that will not require them to walk too far. Properly spaced stock ponds and wells will also make for a more even distribution of grazing over the range.

*Care of the herd.*—Fitting the right kind and number of livestock to the range results in the highest production and in the best use of the range resources. Cattle do best on range that is mostly grass. Sheep make better use of the range if the available forage consists of an abundance of weeds. In Wilbarger County, however, the livestock enterprise is mainly one of cattle and calves, and only a few sheep are raised. Good long-term management requires range improvement for the better production of grasses. Planning a feed and forage program that will make use of the available range forage, concentrates, hay, and temporary cropland pastures is necessary to keep livestock in a productive condition throughout the year.

In addition to providing adequate forage and reserve feed supplies, it is often desirable to keep part of the livestock as a "floater" herd of readily salable stock, such as stocker steers. This allows ranchers to balance the number of livestock on hand with the available forage without sacrificing breeding animals.

The breeding program should provide for the selection of animals best suited to the range, for culling nonproductive animals, for the seasonal arrival of calves to take advantage of forage when it is most nutritious, and for continued improvement of the animals in the herd.

### Tree Windbreaks<sup>3</sup>

Tree windbreaks help to reduce the velocity of wind on farms and ranches. Their main purpose is to protect soils, crops, and farmsteads against wind and blowing soil. They serve as snow fences in winter. They also provide shelter for livestock and are a source of food and cover for birds and other wildlife.

The first windbreak plantings in Wilbarger County were made in 1936. In the next 7 years, about 147 miles of windbreaks were planted in a patchwork pattern, from east to west and from north to south, mainly along land survey lines. Since 1942, about 700 acres of windbreaks have been planted, mainly on individual farms.

There are in the county about 120,000 acres of deep sandy soils that are moderately to highly susceptible to wind erosion and are suitable for field windbreak plantings. They are soils in the Enterprise, Miles, Tipton, and Springer series. These soils are friable, permeable to both water and tree roots, and from 6 to 10 feet deep. Soils in the Enterprise and Tipton series are on low, nearly level to gently rolling terraces and have high natural fertility.

<sup>3</sup> This subsection was prepared by EDWIN C. WILBUR, woodland conservationist, Soil Conservation Service.



Figure 16.—Stand of little bluestem seeded 5 years before this picture was taken. Two years before picture was taken, a good crop of seed was harvested from this picture.

They are the most productive soils in the county for trees. Soils in the Miles series, which are the most extensive sandy soils in the county, rank next in capacity to support a good growth of trees. The average total height at maturity of suited trees is about 5 to 10 feet less for those grown on Miles soils than for those grown on Enterprise and Tipton

angles and are properly spaced, is most effective (fig. 17). Generally, a two-direction pattern is almost twice as effective as a single isolated belt. Quartering winds further reduce the effectiveness of a single isolated belt.

Field windbreaks supplement other conservation practices in protecting soils against wind erosion; they will

TABLE 3.—*Expected average height of suitable trees and shrubs on selected sandy soils*

[Dashes indicate that the tree or shrub is not grown on the particular soil]

Species	Springer loamy fine sand			Miles loamy fine sand			Miles fine sandy loam		
	Age in years			Age in years			Age in years		
	5	10	20	5	10	20	5	10	20
Shortleaf pine	6	1 20	35	7	22	40	7	20	38
Loblolly pine	7	23	1 41	8	24	1 45	8	22	40
Eastern redcedar	4	1 15	28	5	17	1 31	4	16	1 29
Ailanthus				8	21	1 36			
Siberian elm	11	33	1 50	12	35	55	9	30	1 46
Cottonwood	13	37	1 57		10	—	10	33	50
Sycamore				10	22	1 45			
Osage-orange	7	16	1 24				7	14	1 22
Russian mulberry	8	21	1 31	8	23	1 36			
Green ash	7	17	1 24	9	24	1 36			
Desertwillow	5	10	1 13				6	12	1 16
Russian-olive	5	11	1 15						
Apricot	4	8	1 15	4	9	1 17	4	8	1 16
Catalpa	6	12	1 24						
Bur oak	4	11	1 23						
Black walnut	4	17	1 27	5	20	1 36			
Hackberry				7	22	1 40			

<sup>1</sup> Height determined by actual measurement in field.

soils. Springer soils are almost as productive for trees as Miles soils.

Table 3 gives the expected average height, at 5 years, 10 years, and 20 years, of suitable trees and shrubs growing on Springer loamy fine sand, Miles loamy fine sand, and Miles fine sandy loam.

Trees will grow satisfactorily on all these soils if hardy planting stock of suitable species is selected carefully and planted on well-prepared sites. After they are planted, the trees should be cultivated to prevent competition by weeds, and they should be protected against fire. Livestock should be excluded from windbreak plantings of any age.

Two general factors must be considered in locating windbreaks. They are the direction of the prevailing winds during the season of greatest wind damage and the direction of the slope on which the windbreaks are to be planted. On level to gently sloping soils, windbreaks may be planted in straight lines if, in the direction of the belt, the slope does not exceed 3 percent. A combination of east-west belts and north-south belts is most effective. On rolling land, windbreaks should be planted on the contour, provided the contour lines generally are at right angles to the direction of the prevailing wind.

Isolated east-west or north-south windbreaks offer little protection in proportion to the space they occupy. A two-direction pattern, in which the belts of trees are at right

angles and are properly spaced, is most effective (fig. 17). Generally, a two-direction pattern is almost twice as effective as a single isolated belt. Quartering winds further reduce the effectiveness of a single isolated belt.

Windbreaks should be wide enough to give the protection needed in the areas where they are to be planted.



Figure 17.—Windbreak plantings on Miles loamy fine sand.

Ordinarily, a three-row windbreak is the most practical and feasible. A maximum of five rows of trees and shrubs is suggested, but the farmer or rancher may decide that he wants a wider windbreak. At least one row should be of evergreens, or conifers, to furnish maximum protection in winter and in spring.

Information on planning and laying out windbreak plantings can be obtained from the local Soil Conservation District, technicians of the Soil Conservation Service, and the county agent. They will also know where seedlings of good quality can be obtained.

## Wildlife Habitats

The early settlers found an abundance of wildlife in Wilbarger County. The grasses that covered the rolling plains formed natural habitats for buffalo, deer, and prairie chickens. As settlement continued, the grass cover was broken, and the wildlife population gradually declined. It is only recently that the value of wildlife for recreation and other farm purposes has been realized. More and more people are looking to the land for recreation, and hunting and fishing are becoming more important each year.

Wilbarger County supports many kinds of wildlife, including beaver, raccoon, skunk, rabbit, opossum, ground squirrel, coyote, prairie dog, badger, and a few deer. Up-land birds are the bobwhite quail, blue quail, mourning dove, meadowlark, robin, blackbird, crow, hawk, and owl. Many of these animals and birds help to control insects and rodents on the farm.

Wildlife is a secondary agricultural crop. Like other crops, its production depends on how farmers and ranchers use the land. There are many natural habitats in the county, and others can be easily developed. Almost every farm or ranch contains a fence row, windbreak, brush pile, or some unused odd area around a gully or on a streambank, where food and cover for wildlife can be easily provided.

Most areas can be developed by simple practices. The sites should be protected against fire and grazing and against any further erosion. If food is in short supply, plants that produce a good supply of seed can be planted. In some places, this will require the preparation of a good seedbed before planting. Low-growing trees and shrubs can be planted to furnish both food and cover. Any plan should provide food for the entire year.

There are many farm ponds in the county, which are used mostly for watering stock. Many of these ponds can be stocked with fish, but, since they vary in depth and some are dry during part of the year, ponds for stocking should be carefully selected. A farm fishpond should be at least a fourth of an acre in size, and the water over a fourth of the pond should be at least 8 feet deep. Most of the debris and shrubs below the water line should be removed. The pond should be stocked with desirable varieties of fish; channel catfish, bluegill, crappie, and bass are all well suited to this county.

After it is stocked with fish, the pond, and the dam above it, should be fenced for protection against grazing. Cattails, mosses, and other undesirable weeds should be controlled. The pond should be fished regularly.

Information on developing farm fishponds and other wildlife habitats can be obtained from technicians of the Soil Conservation Service or from the county agent.

## Engineering Properties of the Soils<sup>4</sup>

To make the best use of the soil maps, engineers need to know the physical properties of the soil materials and the in-place condition of the soils. This report contains information that engineers can use to—

1. Make soil and land use studies that will assist in the selection and development of industrial, business, residential, and recreational sites.
2. Make preliminary estimates of erosion and runoff for use in designing drainage structures and in planning dams, irrigation systems, terrace systems, or other structures for soil and water conservation.
3. Locate probable sources of gravel, sand, and other materials for use in structures.
4. Correlate pavement performance with kinds of soil and thus develop information that will be useful in the design and maintenance of pavements.
5. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, and other engineering structures, and in planning the detailed surveys of the selected sites.
6. Determine the suitability of the soils for cross-country movement of vehicles and construction equipment.
7. Supplement information from other published maps, reports, and aerial photographs in making maps and reports that can be readily used by engineers.
8. Locate those sites in which the conditions may require special methods or the use of special designs to assure a satisfactory structure.

*The mapping and descriptive reports are somewhat generalized, however, and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.*

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some terms have special meanings in soil science. These terms are defined in the Glossary at the back of this report.

## Engineering Classification Systems

Most highway engineers classify soil materials according to the system approved by the American Association of State Highway Officials (1). It is an engineering-property classification based on mechanical analysis, plasticity, and field performance of soils in highways. In this system, all soils are classified in seven principal groups. The groups range from A-1 (gravelly soils of high bearing capacity, the best soils for subgrades) to A-7 (clay soils having low strength when wet, the poorest soils for subgrades). Within each of the principal groups, the relative engineering value of the soil material is indicated by

<sup>4</sup>This section was prepared by ROY D. THOMPSON, Jr., engineer, Soil Conservation Service.

a group index number. Group indexes range from 0 for the best subgrade material to 20 for the poorest. The group index number is shown in parentheses after the soil group number. The classification of the soils in Wilbarger County by the AASHO system is given in table 4.

Some engineers prefer to use the Unified soil classification system established by the Corps of Engineers, U.S. Army (9). This system is based on the texture and plasticity of soils and their performance as engineering construction materials. Soil materials are classified in eight coarse-grained groups, six fine-grained groups, and one organic group. The classification of the soils in the county by the Unified system is given in table 4.

## Summary of Engineering Properties

Brief descriptions of the soils in Wilbarger County and estimates of their engineering properties are given in table 4.

Classifications by the AASHO system and the Unified system for Abilene, Miles, and Springer soils are based on the engineering test data for those soils shown in table 6. Classifications for Hollister, Tillman, and Vernon soils are based on test data obtained for those soils in Haskell County, Texas. Classifications for the other soils are based on field tests and, to some extent, on information obtained in Haskell County.

The column headed "Permeability" indicates the rate at which water will move through soil material that is not compacted; it is measured in inches per hour. The column headed "Available water capacity" is an approximation of the amount of capillary water in the soil when wet to field capacity. It is measured in inches per inch of soil. When the soil is air dry, this amount of water will wet the soil material described to a depth of 1 inch without deeper percolation. The estimates for permeability and for available water capacity are particularly significant in planning drainage and irrigation systems.

In the column headed "Reaction," the estimated degree of acidity or alkalinity is expressed in pH value, which is the common logarithm of the reciprocal of the hydrogen-ion concentration of a solution. A notation of 7.0 pH indicates precise neutrality; higher values indicate increasing alkalinity, and lower values indicate increasing acidity.

The ratings in the column headed "Dispersion" indicate the degree to which, and the rapidity with which, the soil slakes in water and the soil structure breaks down. Ratings are high, moderate, and low. A rating of "high" indicates that the soil slakes readily, seals over, and resists penetration of water, air, and roots; it is readily eroded by wind and water.

The ratings for shrink-swell potential indicate the volume change to be expected with a change in the moisture content of the soil; that is, shrinking of the soil when it dries and swelling when it takes up moisture. Ratings are high, moderate, and low. In general, soils classified as CH and A-7 have high shrink-swell potential. Clean sands and gravels (structureless, single grain), those having small amounts of nonplastic to slightly plastic fines, and most other nonplastic to slightly plastic soil materials have low shrink-swell potential.

Table 5 outlines the suitability of the soils for various engineering uses. Some of the characteristics of soils that affect their stability in certain structures and in the design

of structures are also stated. The estimates on suitability for winter grading, for use as subgrade and road fill, as a source of topsoil, and for road drainage probably are of most interest to highway engineers. The other columns are of interest to conservation engineers.

The ratings on suitability for winter grading are excellent, good, fair, and poor. As indicated in the table, most of the soils in the county can be graded in winter. Some of the slickspots in Abilene-slickspot complex, however, are underlain by a high water table, which affects winter grading.

Ratings on suitability for use as road subgrade are based on the estimated engineering classifications of the soils, as given in table 4. All ratings are based on the A and B horizons of the soils; if ratings change at any depth, this is noted in the column. The ratings used are good, fair, poor, and very poor. Soils of high plasticity or that have a highly plastic layer, such as Hollister clay loam and Tillman clay loam, have impeded natural drainage and have low stability when wet; hence, they have a rating of "poor." The highly erodible silts and loamy fine sands contain a large proportion of material that passes the No. 200 sieve, are poorly graded, and generally lack stability unless they are properly confined; hence, they have a rating of "poor." Tivoli fine sand has a rating of "fair to good" because it has a low shrink-swell potential and a high bearing capacity.

The suitability of a soil for road-fill material depends largely on its texture, plasticity, and content of water. The ratings used are good, fair, and poor. Plastic soils, such as Hollister clay loam and Tillman clay loam, are difficult to handle, to compact, and to dry to the desired moisture content; hence, they have a rating of "poor." The loams and very fine sandy loams are highly erodible unless properly protected; they have a rating of "poor to fair." The coarse-textured soils have a low degree of compressibility and expansion; they have a rating of "fair to good." To prevent detrimental expansion, the very plastic, expansive soil material from such soils as Hollister clay, Mansker loam, Miller clay loam, and Tillman clay loam should be compacted at a moisture content that is either at or slightly above the optimum moisture content.

The estimated physical properties of the soils in the county indicate that, to the depths explored, there is no suitable source of gravel. Except for the following six soil types, all the soils are unsuitable as a source of sand for highway subbase construction. Altus loamy fine sand is a poor to fair source; Cobb fine sandy loam is a fair source at a depth of more than 3 feet; Lincoln loamy fine sand and Tivoli fine sand are fair sources; and Miles fine sandy loam and Springer loamy fine sand are poor sources.

The stability of the soils in dikes or levees and in embankments is expressed in terms of good, fair, and poor. These estimates of stability are based on the estimated engineering classifications and on field experience. The suitability of the soils for reservoirs, for agricultural drainage, for terraces and diversions, and for waterways is expressed in the rating terms of excellent, good, fair, and poor. The special properties that limit the soils to a rating of "poor," or that must be considered in applying these practices, are given after the rating term. The special soil features, such as slow permeability, shallowness, hum-

mokey surface, and other features that must be considered if the soils are to be irrigated are also listed. These ratings and notations of special features are based on the interpretations of characteristics given in table 4 and on local experience in using the soils.

Table 6 gives the engineering test data for samples from 12 soil profiles in Wilbarger County. The tests were per-

formed by the Texas State Highway Department Testing Laboratory in accordance with standard procedures of the American Association of State Highway Officials. The engineering classifications by both the AASHO system and the Unified system are also listed. The terms used in the headings of this table are explained in the Glossary at the back of this report.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil	Brief description <sup>1</sup>	Depth from surface	Classification
				USDA texture
AbA	Abilene clay loam, 0 to 1 percent slopes.	Outwash of Quaternary or Tertiary age; ancient terraces; level or weakly concave; impeded drainage and saline spots in some areas; slope generally about 0.5 percent.	0 to 8.....	Clay loam.....
AbB	Abilene clay loam, 1 to 3 percent slopes.		8 to 15.....	Silty clay loam.....
Ak	Abilene-slickspot complex.		15 to 28.....	Silty clay to silty clay loam.
Am	Altus fine sandy loam.		28 to 65.....	Silty clay loam to clay.....
Ap	Altus fine sandy loam, poorly drained variant.	Silty sands to inorganic sand-clay mixtures of low to medium plasticity; nearly level; single slopes; surface drainage generally poor; derived from old alluvium or outwash of Pliocene to Pleistocene age.	65 to 96.....	Clay loam to silty clay.....
As	Altus loamy fine sand.	Soils developed from outwash of Pliocene to Pleistocene age; slopes concave and generally less than 0.5 percent.	0 to 7.....	Fine sandy loam.....
			7 to 18.....	Sandy clay loam.....
			18 to 36.....	Clay loam.....
			36 to 55.....	Clay loam.....
			55 to 62+..	Clay loam.....
CoB	Cobb fine sandy loam, 1 to 3 percent slopes.	Sand-silt mixtures over sand-clay mixtures underlain by sandstone; derived from San Angelo sandstone of Permian age; convex, single slopes.	0 to 6.....	Fine sandy loam.....
Cs	Cobb fine sandy loam, shallow variant.		6 to 11.....	Sandy clay loam.....
			11 to 22.....	Sandy clay loam.....
			22 to 30.....	Sandy clay loam.....
			30 to 40.....	Sandy clay loam.....
			40+... ..	Sandstone.....
EfA	Enterprise fine sandy loam, 0 to 1 percent slopes.	Sands and silty sands; wind deposited; poorly graded; nearly level to gently sloping; slightly concave, single slopes; low plasticity.	0 to 6.....	Fine sandy loam.....
EfB	Enterprise fine sandy loam, 1 to 3 percent slopes.		6 to 14.....	Fine sandy loam.....
EnA	Enterprise very fine sandy loam, 0 to 1 percent slopes.	Sands and silty sands; wind deposited; poorly graded; nearly level to gently rolling; slightly concave, single slopes; low plasticity.	0 to 7.....	Very fine sandy loam.....
EnB	Enterprise very fine sandy loam, 1 to 3 percent slopes.		7 to 17.....	Very fine sandy loam.....
EnC	Enterprise very fine sandy loam, 3 to 5 percent slopes.		17 to 62+..	Very fine sandy loam.....
EnD	Enterprise very fine sandy loam, 5 to 8 percent slopes.			
HcA	Hollister clay loam, 0 to 1 percent slopes.	Inorganic clays and clay-silt mixtures; derived from Permian red beds; medium to high plasticity; smooth to nearly level; convex slopes.	0 to 6.....	Clay loam.....
HcB	Hollister clay loam, 1 to 3 percent slopes.		6 to 12.....	Silty clay loam.....
			12 to 22.....	Clay.....
			22 to 46.....	Clay.....
			46 to 62.....	Clay.....
			62 to 68+..	Clay.....
Ln	Lincoln loamy fine sand.	Alluvial sands and sand-silt mixtures; generally has high water table at a depth of less than 5 feet; scattered saline spots; subject to severe wind erosion if inadequately protected by vegetation; very low plasticity; possible source of sand and gravel; undulating to nearly level; subject to overflow.	0 to 10.....	Loamy fine sand.....
			10 to 30.....	Loamy very fine sand.....
			30 to 60+..	Coarse sand.....

*their estimated physical properties*

Classification—Con.		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
CL, CL-ML	A-6 or A-4	100	100	85 to 90	Inches per hour	Inches per inch of soil	pH	Moderate	Moderate.
CL, CL-CH	A-6 or A-7	100	100	90 to 95	0.2 to 0.5	0.14 to 0.21	6.6 to 7.3	Moderate	High.
CL, CL-CH	A-7	100	100	90 to 95	0.2 to 0.5	0.13 to 0.21	6.6 to 7.3	Moderate	High.
CL, CL-CH	A-6 or A-7	100	100	90 to 95	0.2 to 0.5	0.13 to p.21	7.5 to 8.0	Moderate	High.
CL, CL-CH	A-6 or A-7	95 to 100	90 to 100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.5 to 8.0	Moderate to high.	High.
SM	A-2 or A-4	100	85 to 100	30 to 40	0.8 to 2.5	0.14 to 0.18	6.5 to 7.0	Low to moderate	Low.
CL	A-4 or A-6	100	100	70	0.5 to 0.8	0.14 to 0.18	6.5 to 7.0	Moderate	Moderate.
CL, CL-CH	A-7	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Moderate to high.	High.
CL, CL-CH	A-7	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Moderate to high.	High.
SM, SP-SM	A-2	100	100	10 to 20	0.8 to 2.5	0.08 to 0.13	6.6 to 7.3	Low	Low.
SM, SP-SM	A-2	100	100	10 to 20	0.8 to 2.5	0.08 to 0.13	6.6 to 7.3	Low	Low.
CL	A-4 or A-6	100	95 to 100	70 to 75	0.2 to 0.5	0.14 to 0.18	6.6 to 7.3	Low to moderate	Low to moderate.
CL	A-4 or A-6	100	95 to 100	70 to 75	0.2 to 0.5	0.14 to 0.18	6.6 to 7.3	Moderate to high.	Moderate.
CH	A-6 or A-7	100	95 to 100	80 to 85	0.05 to 0.2	0.18 to 0.21	6.6 to 7.3	Moderate to high.	High.
SM	A-4 or A-2	100	95 to 100	25 to 35	0.8 to 2.5	0.11 to 0.14	6.6 to 7.3	Low	Low.
CL	A-4 or A-6	100	95 to 100	75 to 85	0.5 to 0.8	0.14 to 0.18	6.6 to 7.3	Low to moderate	Low to moderate.
CL	A-4 or A-6	100	95 to 100	75 to 85	0.5 to 0.8	0.14 to 0.18	6.6 to 7.3	Low to moderate	Low to moderate.
CL	A-4 or A-6	100	95 to 100	75 to 85	0.5 to 0.8	0.14 to 0.18	6.6 to 7.3	Low to moderate	Low to moderate.
SP or SW	A-3	100	100	0 to 10	1.0 to 1.5	0.08 to 0.13	7.4 to 7.8	Low	Low.
SM	A-4 or A-2	100	95 to 100	25 to 35	0.8 to 2.5	0.11 to 0.14	6.6 to 7.3	Low	Low.
SM	A-4 or A-2	100	95 to 100	25 to 35	0.8 to 2.5	0.11 to 0.14	6.6 to 7.3	Low	Low.
SM	A-4 or A-2	100	95 to 100	25 to 35	0.8 to 2.5	0.11 to 0.14	7.4 to 7.8	Low	Low.
SM or ML	A-4	100	100	50 to 60	0.8 to 2.5	0.13 to 0.20	7.4 to 7.8	Low	Low.
SM or ML	A-4	100	100	50 to 60	0.8 to 2.5	0.13 to 0.20	7.4 to 7.8	Low	Low.
SM or ML	A-4	100	100	50 to 60	0.8 to 2.5	0.13 to 0.20	7.5 to 8.0	Low	Low.
CL, CL-CH	A-6 or A-7	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	6.6 to 7.3	Moderate	Moderate.
CL, CL-CH	A-6 or A-7	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	6.6 to 7.3	Moderate	Moderate.
CL-CH, CH	A-7	100	100	85 to 95	0.05 to 0.2	0.18 to 0.21	6.6 to 7.3	High	High.
CL-CH, CH	A-7	100	99 to 100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.0 to 7.5	High	High.
CH	A-7	100	100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.5 to 8.0	High	High.
CH	A-7	100	100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.5 to 8.5	High	High.
SM	A-2	100	95 to 100	25 to 35	0.8 to 2.5	0.11 to 0.14	7.5 to 8.0	Low	Low.
ML or CL	A-4	100	95 to 100	50 to 55	0.8 to 2.5	0.11 to 0.14	7.5 to 8.0	Low	Low.
SM	A-1 or A-2	100	50 to 60	10 to 15	2.5 to 5.0	0.08 to 0.13	7.5 to 8.0	Low	Low.

TABLE 4.—*Brief description of soils and their*

Map symbol	Soil	Brief description <sup>1</sup>	Depth from surface	Classification
				USDA texture
MaB	Mansker loam, 1 to 3 percent slopes.	Inorganic sand-silt or clay-sand mixtures; derived from outwash material of Pliocene or Pleistocene age; low to medium plasticity; calcium carbonate concretions throughout profile.	0 to 6..... 6 to 11..... 11 to 52..... 52 to 62+....	Loam..... Clay loam..... Clay loam..... Clay loam.....
MaC	Mansker loam, 3 to 5 percent slopes.			
MaD	Mansker loam, 5 to 8 percent slopes.			
MfA	Miles fine sandy loam, 0 to 1 percent slopes.	Silty sands or sand-silt mixtures; derived from old alluvium, or outwash, of Pliocene or Pleistocene age; slopes generally single; low plasticity.	0 to 12.....	Fine sandy loam, sand, or loamy sand.
MfB	Miles fine sandy loam, 1 to 3 percent slopes.		12 to 32.....	Fine sandy loam.....
MfC	Miles fine sandy loam, 3 to 5 percent slopes.		32 to 47.....	Sandy clay loam to sandy clay.
MfC2	Miles fine sandy loam, 2 to 5 percent slopes, eroded.		47 to 67....	Fine sandy loam to sandy clay loam.
MfD	Miles fine sandy loam, 5 to 8 percent slopes.		67 to 90 ...	Sandy clay loam.....
MmB	Miles loamy fine sand, 0 to 3 percent slopes.			
MmC	Miles loamy fine sand, 3 to 5 percent slopes.			
Mr	Miller clay.	Clayey soil formed in recent alluvial sediments derived from Permian red-bed materials; highly plastic; surface drainage and internal drainage poor; seldom to frequently flooded; nearly level.	0 to 4..... 4 to 20..... 20 to 60+....	Clay..... Clay..... Clay.....
Mt	Miller clay loam.	Inorganic silty clays of low to medium plasticity; recent alluvial sediments derived from Permian red-bed materials; nearly level, concave surface; stratified; subject to overflow.	0 to 7..... 7 to 14..... 14 to 60+....	Clay loam..... Silty clay loam..... Clay.....
Nc	Norwood clay loam.			
No	Norwood silt loam.			
Pc	Port clay loam.	Soil formed in recent alluvial sediments from soils formed in materials derived from sandy or clayey outwash materials; good internal drainage; seldom to frequently overflowed; sand-silt, sand-clay, or clay-silt mixtures; low plasticity.	0 to 6..... 6 to 16.... 16 to 60+....	Clay loam..... Clay..... Sandy clay loam.....
Sg	Springer loamy fine sand, hummocky.	Silty sands or sand-silt mixtures; derived from old alluvium or outwash of Permian or Pleistocene age; generally well drained; undulating and hummocky; low plasticity; very susceptible to wind erosion.	0 to 11..... 11 to 33..... 33 to 49..... 49 to 80..... 80 to 90....	Loamy fine sand..... Loamy fine sand to fine sandy loam..... Fine sandy loam..... Sandy clay loam to loamy fine sand..... Loamy fine sand to fine sandy loam.....
Sp	Springer loamy fine sand, undulating.			
TcA	Tillman clay loam, 0 to 1 percent slopes.	Inorganic clays and silt-clay mixtures; derived from Permian red-bed shales and clays; medium to high plasticity; slopes generally convex; on terraces above overflow.	0 to 6..... 6 to 18..... 18 to 36..... 36 to 62+....	Clay loam..... Clay..... Clay..... Silty clay loam.....
TcB	Tillman clay loam, 1 to 3 percent slopes.			
TcB2	Tillman clay loam, 1 to 3 percent slopes, eroded.			
TpA	Tipton silt loam, 0 to 1 percent slopes.	Sand-silt and clay-silt mixtures; derived from old alluvium or outwash; low to medium plasticity; level to slightly rolling.	0 to 6..... 6 to 20..... 20 to 36.... 36 to 66... 66 to 100+...	Silt loam..... Loam..... Sandy clay loam..... Clay loam..... Clay loam.....
TpB	Tipton silt loam, 1 to 3 percent slopes.			
Tv	Tivoli fine sand.	Inorganic sands; eolian sands of Quaternary age; hummocky; slopes complex and generally 100 feet or less in length; very low plasticity; subject to severe wind erosion if not adequately protected by vegetation.	0 to 14..... 14 to 100+...	Fine sand..... Fine sand.....

## estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
ML	A-4	100	100	80 to 85	Inches per hour 0.8 to 2.5	Inches per inch of soil 0.13 to 0.21	pH 7.0 to 7.5	Moderate	Moderate.
CL, CL-CH	A-7	100	100	80 to 85	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Moderate	High.
CL, CL-CH	A-7	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Moderate	High.
CL, CL-CH	A-7	100	100	80 to 90	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Moderate	High.
SM	A-2	100	100	15 to 20	0.8 to 2.5	0.11 to 0.14	6.6 to 7.0	Low	Low.
SM, SM-SC	A-4 or A-2	100	100	35 to 40	0.8 to 2.5	0.11 to 0.14	6.6 to 7.0	Low	Low.
SC, CL	A-6 or A-7	100	95 to 100	45 to 50	0.2 to 0.8	0.14 to 0.21	6.6 to 7.0	Low to moderate	Low to moderate.
SC, SM SC	A-2 or A-6	100	100	35 to 40	0.2 to 0.8	0.11 to 0.18	6.6 to 7.0	Low to moderate	Low to moderate.
CL, CL CH	A-6 or A-7	100	95 to 100	45 to 50	0.5 to 0.8	0.14 to 0.18	6.6 to 7.0	Low to moderate	Low to moderate.
CH	A-7	100	95 to 100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.0 to 7.5	High	High.
CH	A-7	100	95 to 100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.0 to 7.5	High	High.
CH	A-7	100	95 to 100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.0 to 7.5	High	High.
CL, CL CH	A-7	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.4 to 7.8	Moderate	High.
CL, CL-CH	A-7	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.4 to 7.8	Moderate	High.
CL, CL-CH	A-7	100	100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.5 to 8.0	High	High.
ML	A-4	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.5 to 8.0	Low to moderate	Moderate.
ML or MH	A-4	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.5 to 8.0	Low to moderate	Moderate.
CL, CL-CH	A-4 or A-6	100	95 to 100	85 to 90	0.2 to 0.5	0.13 to 0.21	6.5 to 7.0	Moderate to high	Moderate.
CL, CL-CH	A-4 or A-6	100	100	90 to 95	0.05 to 0.2	0.18 to 0.21	6.5 to 7.0	High	High.
CL, CL-CH	A-6 or A-7	100	95 to 100	80 to 85	0.5 to 0.8	0.14 to 0.18	6.5 to 7.0	Moderate to high	High.
SM, SP-SM	A-2-4	100	100	15 to 20	0.8 to 2.5	0.08 to 0.14	6.5 to 7.0	Low	Low.
SM	A-2	100	75 to 80	25 to 30	0.8 to 2.5	0.11 to 0.14	6.5 to 7.0	Low	Low.
SM	A-4 or A-2-4	100	100	25 to 40	0.8 to 2.5	0.11 to 0.14	6.5 to 7.0	Low	Low.
ML or CL	A-4 or A-6	100	95 to 100	70 to 75	0.8 to 2.5	0.15 to 0.18	7.0 to 7.5	Low	Low.
SM	A-2-4	100	100	15 to 20	0.8 to 2.5	0.08 to 0.14	7.0 to 7.5	Low	Low.
CL, CL-CH	A-6 or A-7	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Moderate	High.
CL, CL-CH	A-7	100	95 to 100	90 to 95	0.05 to 0.2	0.13 to 0.21	7.0 to 7.5	High	High.
CL, CL-CH	A-6 or A-7	96 to 100	95 to 100	90 to 95	0.05 to 0.2	0.13 to 0.21	7.5 to 8.0	High	High.
CL	A-6 or A-7	100	95 to 100	90 to 95	0.05 to 0.2	0.13 to 0.21	7.5 to 8.0	High	High.
ML	A-4	100	90 to 100	50 to 55	0.8 to 2.5	0.14 to 0.18	7.0 to 7.5	Low to moderate	Moderate.
ML	A-4	100	100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Low to moderate	Low to moderate.
CL	A-4 or A-6	100	95 to 100	70 to 75	0.5 to 0.8	0.14 to 0.18	7.0 to 7.5	Moderate	Moderate.
CL-CH	A-6 or A-7	100	95 to 100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Moderate	High.
CL-CH	A-6 or A-7	100	90 to 100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.5 to 8.0	Moderate	High.
SM	A-2	100	95 to 100	15 to 20	2.5 to 5.0	0.07 to 0.08	7.0 to 7.5	Low	Low.
SP-SM	A-3	100	95 to 100	10 to 15	2.5 to 5.0	0.07 to 0.08	7.0 to 7.5	Low	Low.

TABLE 4.—*Brief description of soils and their*

Map symbol	Soil	Brief description <sup>1</sup>	Depth from surface	Classification	
				USDA texture	
VcC	Vernon clay loam, 2 to 5 percent slopes.	Inorganic clays and sand-clay mixtures; high plasticity; derived from clays and shales of Permian red beds.	<i>Inches</i> 0 to 5... 5 to 11... 11 to 30... 30 to 38+...	Clay loam.....	Clay loam.....
				Clay loam.....	Clay loam.....
				Clay.....	Clay.....
Vx	Vernon complex.	Inorganic clays; high plasticity; derived from clays and shales of Permian red beds; occasional to frequent gullies.	0 to 4... 4 to 8... 8+....	Clay.....	Clay.....
WcA WcB	Wichita clay loam, 0 to 1 percent slopes. Wichita clay loam, 1 to 3 percent slopes.	Inorganic silt-clay mixtures formed in old alluvium, or plains outwash; derived in part from Permian red beds; gently rolling; single slopes; medium plasticity.	<i>Inches</i> 0 to 8... 8 to 12... 12 to 26... 26 to 40... 40 to 55+...	Clay loam.....	Clay loam.....
				Clay loam.....	Clay loam.....
WmA	Wichita loam, 0 to 1 percent slopes.	Silty sands and sand-clay mixtures over clay-sand mixtures of moderate to high plasticity; formed in old alluvium, or plains outwash; derived in part from Permian red beds; nearly level, old terraces.	<i>Inches</i> 0 to 8... 8 to 12... 12 to 24... 24 to 50... 50 to 60+...	Clay loam.....	Clay loam.....
				Loam.....	Loam.....
Ya	Yahola very fine sandy loam.	Sandy alluvial material along streambanks; low plasticity; seldom overflowed; nearly level; single slopes; scattered small saline spots.	<i>Inches</i> 0 to 6... 6 to 16... 16 to 60+...	Sandy clay loam.....	Sandy clay loam.....
				Sandy clay.....	Sandy clay.....
				Very fine sandy loam..	Very fine sandy loam..
				Very fine sandy loam..	Very fine sandy loam..

<sup>1</sup> Depth to water table shown only where significant; that is, at a depth of less than 5 feet.

TABLE 5.—*Engineering*

Soil type and symbol	Suitability for winter grading	Suitability for use as—		Suitability as source of topsoil	Suitability for drainage of roads	Stability in dikes or levees
		Road subgrade	Road fill			
Abilene clay loam (AbA, AbB). Abilene-slickspot complex (Ak).	Fair.....	Poor to fair; high shrink-swell potential.	Poor to fair; high shrink-swell potential.	Good.....	Poor to fair.....	Fair to good; use flat slopes.
Altus fine sandy loam (Am). Altus fine sandy loam, poorly drained variant (Ap).	Fair to good.	Poor to fair; below 18-inch depth, has high shrink-swell potential.	Poor to fair; below 18-inch depth, has high shrink-swell potential.	Poor.....	Poor to fair; slow internal drainage below 18-inch depth.	Poor; fair with flat slopes.
Altus loamy fine sand (As).	Fair.....	Fair to good to a depth of 18 inches; poor to fair below.	Poor to fair.....	Good.....	Poor; impervious below 28-inch depth.	Fair; use for cores or dikes.
Cobb fine sandy loam (CoB). Cobb fine sandy loam, shallow variant (Cs). Enterprise fine sandy loam (EfA, EfB).	Excellent...	Poor to fair; good below 40-inch depth.	Poor to fair.....	Poor.....	Poor to fair.....	Good for cores.
		Poor to fair.....	Poor to fair; subject to water erosion if not protected.	Fair to good.	Good; good internal drainage.	Fair; use flat slopes.

*estimated physical properties—Continued*

Classification—Con.		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
CL, CL-CH	A-6 or A-7	100.....	95 to 100	85 to 90	Inches per hour 0.2 to 0.5	Inches per inch of soil 0.13 to 0.21	pH 7.0 to 7.5	Moderate to high.	High.
CL, CL-CH	A-6 or A-7	100.....	95 to 100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.0 to 7.5	Moderate to high.	High.
CH	A-7	100.....	95 to 100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.0 to 7.5	High	High.
CH	A-7	100.....	95 to 100	90 to 95	0.05 to 0.2	0.18 to 0.21	7.0 to 7.5	High	High.
CH	A-7	100.....	95 to 100	85 to 95	0.05 to 0.2	0.18 to 0.21	7.0 to 7.5	High	High.
CL, CL-CH	A-6 or A-7	99 to 100	95 to 99	85 to 95	0.2 to 0.5	0.13 to 0.21	6.6 to 7.3	Moderate	High.
CL, CL-CH	A-6 or A-7	99 to 100	95 to 99	85 to 90	0.2 to 0.5	0.13 to 0.21	6.6 to 7.3	Moderate	High.
CL, CL-CH	A-6 or A-7	100.....	95 to 100	85 to 90	0.2 to 0.5	0.13 to 0.21	6.6 to 7.3	Moderate	High.
CL, CL-CH	A-6 or A-7	100.....	95 to 100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.5 to 8.0	Moderate	High.
CL, CL-CH	A-6 or A-7	100.....	95 to 100	85 to 90	0.2 to 0.5	0.13 to 0.21	7.5 to 8.0	Moderate	High.
SM	A-2	100.....	95 to 100	35 to 40	0.8 to 2.5	0.11 to 0.14	6.6 to 7.3	Low to moderate.	Low to moderate.
ML or CL	A-4 or A-6	100.....	95 to 100	60 to 65	0.5 to 0.8	0.14 to 0.18	6.6 to 7.3	Low to moderate.	Moderate.
SC	A-6 or A-7	100.....	55 to 100	45 to 50	0.5 to 0.8	0.14 to 0.18	6.6 to 7.3	Moderate	Low to moderate.
CL, CL-CH, CH	A-6 or A-7	100.....	97 to 100	70 to 75	0.2 to 0.5	0.13 to 0.21	6.6 to 7.3	Moderate to high.	High.
CL, CL-CH, CH	A-6 or A-7	100.....	97 to 100	70 to 75	0.2 to 0.5	0.13 to 0.21	6.6 to 7.3	Moderate to high.	High.
ML	A-4	100.....	100	60 to 65	0.8 to 2.5	0.13 to 0.20	7.5 to 8.0	Low	Low to moderate.
ML	A-4	100.....	100	60 to 65	0.8 to 2.5	0.13 to 0.20	7.5 to 8.0	Low	Low to moderate.
ML	A-4	100.....	100	60 to 65	0.8 to 2.5	0.13 to 0.20	7.5 to 8.0	Low	Low to moderate.

*interpretations of the soils*

Suitability for reservoirs	Stability in embankments	Suitability for agricultural drainage	Soil factors affecting irrigation	Suitability for—	
				Terraces and diversions	Waterways
Fair to good	Fair to good; use flat slopes; use for impervious cores and blankets.	Poor	Low permeability	Good	Good.
Good to excellent.	Fair to good; use flat slopes; use for impervious cores and blankets.	Poor to fair; below 18-inch depth has poor internal drainage; generally has poor surface drainage.	Low permeability of soil below 18-inch depth.	Fair to good	Fair to good.
Fair to good	Fair to poor; fair to a depth of 18 inches; poor to fair below.	Poor	Low water-holding capacity to a depth of 18 inches.	Good	Good; subject to wind erosion if not adequately protected by vegetation.
Fair to good	Fair to good; use for impervious cores.	Fair	Shallowness of soil over sandstone.	Good	Good if little excavation is required.
Poor; excessive seepage.	Fair; use flat slopes	Good; good internal drainage.	High permeability; accumulations of soil blown by wind affect land leveling; rolling topography.	Poor; subject to wind erosion if not adequately protected.	Poor; subject to wind and water erosion.

TABLE 5.—*Engineering interpretations*

Soil type and symbol	Suitability for winter grading	Suitability for use as—		Suitability as source of topsoil	Suitability for drainage of roads	Stability in dikes or levees
		Road subgrade	Road fill			
Enterprise very fine sandy loam (EnA, EnB, EnC, EnD).	Good-----	Fair to good if properly compacted.	Fair to good if properly compacted.	Excellent---	Fair to poor----	Fair to good--
Hollister clay loam (HcA, HcB).	Fair-----	Poor-----	Poor to good-----	Poor to fair.	Poor-----	Good to fair; use flat slopes.
Lincoln loamy fine sand (Ln).	Excellent---	Fair to good-----	Fair to good-----	Poor-----	Fair-----	Poor; may be used with proper control.
Mansker loam (MaB, MaC, MaD).	Fair-----	Poor-----	Poor to good-----	Fair to good.	Poor-----	Fair to good; use flat slopes.
Miles fine sandy loam (MfA, MfB, MfC, MfC2, MfD). Miles loamy fine sand (MmB, MmC).	Good-----	Fair to good-----	Good; stable if dry.	Good-----	Fair to good except where water table is high; subject to water erosion.	Poor; fair if used with proper controls.
Miller clay (Mr).	Poor-----	Poor; high shrink-swell potential.	Poor; high shrink-swell potential.	Poor-----	Poor to fair; very slow internal drainage.	Poor to fair; use flat slopes.
Miller clay loam (Mt).	Fair-----	Poor to fair-----	Poor-----	Fair-----	Poor; nearly impervious below 14-inch depth.	Fair to good; use flat slopes.
Norwood clay loam (Nc). Norwood silt loam (No).	Good-----	Fair-----	Fair; unstable when wet.	Fair-----	Poor to fair-----	Poor-----
Port clay loam (Pc).	Fair-----	Fair; high shrink-swell potential.	Fair; high shrink-swell potential.	Poor to fair.	Poor; poor internal drainage.	Poor to fair; use flat slopes; use for blankets.
Springer loamy fine sand, hummocky (Sg). Springer loamy fine sand, undulating (Sp).	Excellent---	Fair to good-----	Fair to good; subject to water erosion if not protected.	Fair to good.	Good; good internal drainage.	Fair; use flat slopes.
Tillman clay loam (TcA, TcB, TcB2).	Poor to fair.	Poor; high shrink-swell potential.	Poor; high shrink-swell potential.	Fair-----	Very poor; impervious below 6-inch depth.	Fair to good; use flat slopes.
Tipton silt loam (TpA, TpB).	Fair to good.	Poor to fair; high shrink-swell potential.	Poor to fair; high shrink-swell potential.	Good to excellent.	Poor to fair; impervious below 20-inch depth.	Fair; fairly stable material below 20-inch depth if flat slopes used.

## of the soils—Continued

Suitability for reservoirs	Stability in embankments	Suitability for agricultural drainage	Soil factors affecting irrigation	Suitability for—	
				Terraces and diversions	Waterways
Poor-----	Fair; may be used for cores.	Excellent-----	Moderate permeability affects surface irrigation designs. Low permeability below 12-inch depth.	Poor; rolling topography; subject to wind erosion. Good-----	Poor; subject to erosion. Poor; soil has poor to fair stability.
Excellent-----	Fair to good; use flat slopes.	Fair; internal drainage poor below 12-inch depth.			
Poor-----	Poor; may be used with proper control.	Poor to fair; high water table.	Low water-holding capacity.	Poor; too sandy; complex slopes.	Poor; rolling, hummocky topography; accumulations of windblown soil a problem.
Poor to fair; moderate seepage.	Fair to good; use flat slopes.	Poor; internal drainage slow.	Land leveling on steeper slopes affected by shallowness of topsoil; calcium carbonate concretions in the subsoil.	Poor; high shrink-swell potential.	Poor to fair; soil has poor to fair stability.
Poor; excess seepage.	Poor; fair if used with proper controls.	Fair to good; subject to water erosion.	High permeability affects surface-system design; complex slopes affect land leveling; water table high in some places near creeks.	Poor; subject to wind erosion if not adequately protected by vegetation; gully erosion a problem in some places.	Good; accumulations of windblown soil in some places; subject to water erosion.
Excellent-----	Poor to fair; high shrink-swell potential; use flat slopes; use for thin cores or blankets; high dispersion.	Poor; very slow internal drainage.	Low permeability; high shrink-swell potential; high dispersion; frequent flooding.	Poor; high dispersion; high shrink-swell potential; frequent flooding.	Poor; subject to flooding; highly dispersed; high shrink-swell potential.
Fair to good--	Fair to good; use flat slopes; use for impervious cores and blankets.	Poor; slow internal drainage.	Periodic flooding; low permeability; shallow surface soil affects land leveling.	Poor; complex slopes; periodic flooding.	Poor; poor stability; flooding problem if not parallel to natural drains.
Poor to fair; excessive seepage in some places.	Poor; may be used with proper control.	Poor; slow internal drainage; stratification; moderate dispersion.	Frequently flooded; stratification; moderate dispersion; saline spots.	Poor; frequently flooded; complex slopes.	Poor; frequently flooded; moderate dispersion; saline spots.
Good to excellent.	Poor to fair; high shrink-swell potential; moderate to high dispersion.	Poor; poor internal drainage.	Subject to flooding in places; subject to runoff from other soils in places.	Poor; subject to flooding in places.	Poor; needs grade-stabilization structure at outlet end in some places; subject to flooding in places; fairly stable.
Poor; excessive seepage.	Fair; use flat slopes; not suitable for shells.	Good; good internal drainage.	High permeability; accumulations of windblown soil on leveled land; rolling topography.	Poor; subject to wind erosion if not adequately protected.	Poor; subject to wind and water erosion.
Excellent-----	Fair to good; use flat slopes; use for impervious cores and blankets; high shrink-swell potential.	Poor; very slow internal drainage below 6-inch depth; high dispersion of subsurface layers.	Low permeability below 6-inch depth.	Poor; plastic and sticky when wet; high shrink-swell potential.	Poor to fair; high shrink-swell potential.
Good to excellent.	Poor to fair; high shrink-swell potential below 20-inch depth; high dispersion; fairly stable for impervious cores and embankments.	Poor to fair; very slow internal drainage below 20-inch depth.	Low permeability below 20-inch depth; high dispersion.	Poor; high shrink-swell potential below 20-inch depth; subject to wind erosion.	Poor; accumulations of windblown soil; subject to water erosion.

TABLE 5.—*Engineering interpretations*

Soil type and symbol	Suitability for winter grading	Suitability for use as—		Suitability as source of topsoil	Suitability for drainage of roads	Stability in dikes or levees
		Road subgrade	Road fill			
Tivoli fine sand (Tv).	Excellent----	Fair to good-----	Fair to good-----	Fair-----	Very good; excellent internal drainage.	Fair; use flat slopes; protect against wind erosion.
Vernon clay loam (VcC).	Fair-----	Poor to fair; high shrink-swell potential.	Poor to fair; high shrink-swell potential.	Poor-----	Poor; very slow internal drainage.	Fair; use flat slopes; use for thin cores and blankets.
Vernon complex (Vx).	Fair when dry; poor when wet.	Poor to fair; high shrink-swell potential.	Poor to fair; high shrink-swell potential.	Poor-----	Poor; very slow internal drainage.	Fair; use flat slopes; use for thin cores and blankets.
Wichita clay loam (WcA, WcB).	Fair-----	Poor to fair; moderate shrink-swell potential.	Poor to fair; moderate shrink-swell potential.	Fair-----	Poor to fair; internal drainage is fair.	Fair to good; use flat slopes; use for cores.
Wichita loam (WmA).	Fair to good.	Poor to fair; high shrink-swell potential.	Poor to fair; high shrink-swell potential.	Fair-----	Poor to fair; slow internal drainage below 24-inch depth.	Poor to fair; use flat slopes.
Yahola very fine sandy loam (Ya).	Good-----	Poor to fair-----	Poor to fair-----	Fair to good.	Poor to fair; good internal drainage.	Fair-----

TABLE 6.—*Engineering test data for soil samples*

Soil and location	Parent material	Sample designation	Depth	Horizon	Shrinkage		Field moisture equivalent
					Limit	Ratio	
Abilene clay loam: 3.5 miles north, 0.7 mile west of Vernon (modal profile).	Clayey outwash-----	7-1 <i>Inches</i> 7-2      0 to 8      A <sub>p</sub> ----- 7-3      15 to 28      B <sub>2</sub> ----- 28 to 65      B <sub>ca</sub> -----			Percent	Percent	
6.8 miles south, 2 miles west of Vernon (finer textured B horizon).	Clayey outwash-----	3-1      0 to 5      A <sub>1p</sub> ----- 3-2      14 to 22      B <sub>21</sub> ----- 3-3      43 to 63      B <sub>ca</sub> -----			17	1.78	24
2.5 miles northeast of Oklaunion (contains a B <sub>3</sub> horizon).	Clayey outwash-----	6-1      0 to 7      A <sub>p</sub> ----- 6-2      17 to 26      B <sub>2</sub> ----- 6-3      42 to 63      C <sub>ca</sub> -----			13	1.91	29
Miles fine sandy loam: 0.5 mile west, 0.5 mile south of Elliott (modal profile).	Sandy outwash-----	4-1      0 to 7      A <sub>p</sub> ----- 4-2      14 to 29      B <sub>2</sub> ----- 4-3      40 to 66      C <sub>ca</sub> -----			13	1.96	27
					15	1.85	25
					14	1.90	31
					11	2.02	32
					17	1.77	24
					15	1.87	30
					14	1.88	25
					15	1.83	19
					17	1.80	23
					12	1.97	16

See footnotes at end of table.

of the soils—Continued

Suitability for reservoirs	Stability in embankments	Suitability for agricultural drainage	Soil factors affecting irrigation	Suitability for—	
				Terraces and diversions	Waterways
Poor to fair; excessive seepage.	Fair; use flat slopes; protect against wind erosion.	Very good; excellent internal drainage.	High permeability affects surface-system designs; low available water holding capacity.	Poor; subject to wind erosion; hummocky; complex slopes.	Poor; accumulations of windblown soil; subject to water erosion.
Excellent	Poor to fair; use flat slopes; use for thin cores or blankets; high shrink-swell potential; high dispersion.	Poor; very slow internal drainage.	Low permeability; high dispersion.	Poor; high dispersion; high shrink-swell potential.	Poor; high shrink-swell potential; high dispersion; establishment of vegetation difficult; subject to water erosion if not protected.
Excellent	Poor to fair; use flat slopes; use for thin cores or blankets; high dispersion; high shrink-swell potential.	Poor; very slow internal drainage.	Low permeability; rough gullied topography; high dispersion; high shrink-swell potential.	Poor; high dispersion; high shrink-swell potential; gully erosion; low permeability.	Poor; rough gullied topography; subject to water erosion; high dispersion; establishment of vegetation difficult.
Fair to good	Good to fair; use for impervious cores and blankets.	Poor to fair	Gently rolling topography affects surface irrigation designs.	Good	Poor; establishment of vegetation difficult.
Excellent	Poor to fair; use flat slopes; use as impervious cores; use proper controls; high shrink-swell potential.	Poor to fair; slow internal drainage below 24-inch depth.	Low permeability below 24-inch depth.	Good if at proper moisture content; sticky when wet.	Poor; high shrink-swell potential; low permeability in substrata; moderate to high dispersion.
Poor to fair; excessive seepage.	Fair; use for impervious cores; do not use for shells.	Good to excellent; good internal drainage.	Seldom flooded; saline spots in places; moderate permeability affects surface-system designs.	Fair to good; seldom flooded.	Poor; accumulations of windblown soil; subject to water erosion; needs grade-stabilization structures at outlet end.

from 12 soil profiles in Wilbarger County<sup>1</sup>

Mechanical analysis <sup>2</sup>										Liquid limit	Plasticity index	Classification		
Percentage passing sieve—								Percentage smaller than				AASHO <sup>3</sup>	Unified <sup>4</sup>	
1½ in.	1 in.	¾ in.	⅜ in.	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.250 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.			
—	—	—	—	100	99	98	93	81	24	19	29	10	CL.	
—	—	—	—	100	99	98	94	88	44	38	46	26	CL.	
—	—	—	—	100	96	95	91	87	48	40	49	32	CL.	
—	—	—	—	100	99	98	93	82	33	25	32	13	CL.	
—	—	—	—	100	99	98	94	88	47	42	49	29	CL.	
—	—	—	—	100	99	98	93	81	50	43	51	32	CH.	
—	—	—	—	100	99	96	87	75	22	16	28	8	CL.	
—	—	—	—	100	99	98	91	82	38	33	44	24	CL.	
—	—	—	—	100	99	94	88	83	70	38	31	35	19	CL.
—	—	—	—	100	87	76	55	48	15	13	21	4	ML-CL.	
—	—	—	—	100	91	82	62	57	26	23	33	17	CL.	
100	99	97	95	92	90	80	65	47	45	27	19	7	SM-SC.	

TABLE 6.—*Engineering test data for soil samples from 12*

Soil and location	Parent material	Sample designation	Depth	Horizon	Shrinkage		Field moisture equivalent
					Limit	Ratio	
Miles fine sandy loam—Continued 3.0 miles east, 0.25 mile south of Elliott (finer textured B horizon).	Sandy outwash-----	5-1 5-2 5-3	Inches 0 to 6 14 to 24 36 to 52	A <sub>p</sub> - B <sub>2</sub> - C <sub>ea</sub> -	Percent 17 14 9	1.79 1.90 2.07	Percent 21 28 24
11.0 miles northwest of Vernon (no B <sub>ca</sub> or C <sub>ea</sub> horizons).	Sandy outwash-----	8-1 8-2 8-3	0 to 5 12 to 27 27 to 54	A <sub>p</sub> - B <sub>22</sub> - B <sub>31</sub> -	16 14 15	1.83 1.88 1.85	19 25 19
Miles loamy fine sand: 2.25 miles south, 2 miles west of Vernon (modal profile).	Sandy outwash-----	1-1 1-2 1-3	0 to 12 12 to 32 47 to 67	A <sub>p</sub> - B <sub>21</sub> - C-	16 16 16	1.75 1.81 1.78	17 19 18
2.5 miles west, 0.8 mile south of Lockett (shallow).	Sandy outwash-----	11-1 11-2 11-3	0 to 8 16 to 29 29 to 45	A <sub>p</sub> - B <sub>2</sub> - D-	15 16 14	1.83 1.83 1.88	16 19 22
6.8 miles southwest of Lockett (coarse-textured B <sub>2</sub> horizon).	Sandy outwash-----	12-1 12-2	0 to 10 18 to 34	A <sub>1p</sub> - B <sub>2</sub> -	15 16	1.76 1.80	17 17
Springer loamy fine sand: 3.0 miles south, 2.25 miles west of Vernon (modal profile).	Eolian sands-----	2-1 2-2	0 to 11 33 to 49	A <sub>p</sub> - B <sub>22</sub> -	16 16	1.75 1.77	17 18
1 mile east, 0.5 mile south of Odell (finer textured B horizon).	Eolian sands-----	10-1 10-2	0 to 14 21 to 36	A <sub>p</sub> - B <sub>2</sub> -	15 15	1.75 1.81	16 17
2 miles east, 0.7 mile north of Odell (no buried horizons).	Eolian sands-----	9-1 9-2 9-3	0 to 11 23 to 46 62 to 101	A <sub>p</sub> - B <sub>2</sub> - C-	15 17 17	1.78 1.77 1.77	16 19 16

<sup>1</sup> Tests performed by Texas Highway Department in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (1).

<sup>2</sup> Mechanical analyses according to the American Association of State Highway Officials Designation: T 88 (1). Results by this procedure frequently differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine

## Formation and Classification of the Soils

In this section, the factors that have affected the development and composition of the soils in Wilbarger County are discussed, and the soils are classified by higher categories. Complete physical and chemical data for these soils are not available; therefore, the discussion of classification and morphology is incomplete.

## Factors of Soil Formation

The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent materials, (2) the climate in which the soil material has accumulated and in which the soil-forming processes have taken place, (3) the plant and animal life in and on the soil, (4) the relief, or lay of the land, and (5) the length of time in which the various changes have occurred.

Climate and living organisms are the active factors of soil formation. Through the series of changes set in motion by the energy and moisture contributed by climate and by the activity of living organisms, including vegetation, genetically related horizons are slowly differentiated. The effects of climate and vegetation are conditioned by relief. The parent material, which is accumulated by the weathering of rock and unconsolidated deposits, also affects the kind of soil that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of parent material into a soil. The length of time may be great or small, but generally a long time is required for the development of distinct horizons in a soil.

The interrelationships among the five factors of soil formation are complex, and the effects of any one factor are difficult to isolate. Each factor is discussed separately in the following paragraphs, but it is the interaction of all these factors, rather than their simple sum, that determines the nature of the developed soil.

soil profiles in Wilbarger County<sup>1</sup>—Continued

Mechanical analysis <sup>2</sup>												Liquid limit	Plasticity index	Classification				
Percentage passing sieve—															AASHO <sup>3</sup>	Unified <sup>4</sup>		
1½ in.	1 in.	¾ in.	⅜ in.	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.250 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.							
				100	99	91	84	67	58	18	16	Percent	Percent	A-4(6)	ML-CL.			
				100	99	93	90	80	73	37	32			24	CL.			
				100	99	98	92	90	81	47	39			22	CL.			
				100	99	98	88	79	50	42	17	14	22	5	A-4(3)	SM-SC.		
				100	99	99	93	86	66	60	32	28	36	20	A-6(10)	CL.		
				100	99	89	81	51	40	21	19	27	11	A-6(4)	CL.			
				100	97	86	86	36	29	10	9	18	2	A-4(0)	SM.			
				100	97	89	89	49	45	20	18	23	8	A-4(3)	SC.			
				100	95	84	84	33	31	16	15	23	5	A-2-4(0)	SM-SC.			
				100	89	60	60	16	12	4	3	18	2	A-2-4(0)	SM.			
				100	90	70	70	32	29	17	16	22	6	A-2-4(0)	SM-SC.			
				100	94	78	78	46	44	26	24	32	17	A-6(4)	SC.			
				100	91	70	70	25	20	5	4	18	2	A-2-4(0)	SM.			
				100	91	73	73	34	30	15	13	20	4	A-2-4(0)	SM SC.			
				100	96	75	75	12	11	6	5	21	2	A-2-4(0)	SP-SC.			
				100	95	77	77	25	24	13	12	20	3	A-2-4(0)	SM.			
				100	91	72	72	22	16	7	5	19	3	A-2-4(0)	SM.			
				100	90	72	72	28	23	12	11	19	3	A-2-4(0)	SM.			
				100	91	70	70	16	12	6	5	20	3	A-2-4(0)	SM.			
				100	97	88	88	41	33	13	11	20	3	A-4(1)	SM.			
				100	89	70	70	15	13	6	4	18	2	A-2-4(0)	SM.			

material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

<sup>3</sup> Based on AASHO Designation: M 145-49, The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes (1).

<sup>4</sup> Based on the Unified Soil Classification System (9).

### Parent materials

Most of Wilbarger County is underlain by the interbedded shales, clays, and sandstones, along with some limestone and conglomerate, of the Permian red beds. The oldest of the red-bed formations, the Wichita group, crops out in places in the southeastern part of the county. The Clear Fork group, the next oldest, is the most extensive. From its western boundary, near the community of Farmers Valley north to Odell, this group extends across the entire county and crops out in many places. The smallest and youngest group, the Double Mountain, crops out in a narrow band in the northwestern part of the county (5).

Most of the soils in the county formed in red-bed materials have developed in the clayey residuum of the clays and shales of the Clear Fork group and, to some extent, of the Wichita group. The soils that formed in the sandy red-bed materials probably developed in the sandy residuum of the San Angelo sandstone of the Double Mountain group, which extends to and beyond the Red River into Oklahoma.

Three general groups of soils developed in the clayey residuum of Permian clays and shales. The differences among the three groups result chiefly from differences in slope. The first group consists of deep soils in the Hollister and Tillman series, which developed on gently sloping to nearly level plains. These soils, which are as much as 80 inches deep in places, are mature soils that show a maximum degree of development, or horizon differentiation. They have a dense, compact, clayey subsoil. Water moves through these soils very slowly. The lower layers are seldom moist.

The second group of soils formed from the clayey red-bed materials have developed on gently sloping and moderately sloping ridges and side slopes of drains. The soils are shallow, generally less than 24 inches deep. Vernon clay loam is in this group.

The third group formed from the clayey red-bed materials consists of very shallow soils that occupy moderately sloping to steep ridges and side slopes of drains. They are so susceptible to the forces of erosion that there

are few signs of soil development. Vernon complex and Rough broken land, clayey, are examples of these young soils, which ordinarily are less than 10 inches deep.

Similarly, the soils that developed in the sandy residuum of Permian sandstones fall in two general groups. Cobb fine sandy loam is a moderately deep soil that developed on gently sloping to moderately sloping ridges. Cobb fine sandy loam, shallow variant, developed on moderately to steeply sloping ridges and side slopes of drains.

The outwash parent materials are a part of the Seymour formation of Quaternary (Pleistocene) age, which rests unconformably on the Permian red beds. This formation consists of beds of alluvial sandy clay, sand, and gravel that were deposited by streams flowing from the west (7). In most places, the sand and gravel are in the basal part of the formation, which ranges in thickness from a few inches to about 120 feet in the center of the Sand Hills area in the northern part of the county (10).

The thick beds of sandy material were deposited by fast-moving water. After deposition they probably were reworked by the wind into the present undulating and hummocky topography. Soils in the Altus, Miles, and Springer series have developed in this kind of parent material. These soils show distinct horizon differentiation and are as much as 10 feet deep.

The clayey outwash materials were deposited by slow-moving water. The clay and silty clay particles, which had been held in suspension for a long time, filled the inter-stream valleys and formed a relatively smooth plain. Soils in the Abilene, Mansker, Tipton, and Wichita series developed in this kind of parent material. They are well developed, show distinct horizon differentiation, and probably are older than the soils developed in the sandy outwash materials. Like the soils developed in red-bed materials, these soils range from very shallow to as much as 6 feet deep, dependent chiefly on slope.

In places along the Pease and Red Rivers in the northern part of the county, there is a thick mantle of wind-laid sands and silts blown from the channels of rivers that drain the plains of western Oklahoma and Texas. These materials are being continuously deposited and reworked by the wind. Soils in the Enterprise and Tivoli series formed in these wind-laid materials. They are deep soils. The horizons are indistinct, and there is no B horizon.

Recent alluvial deposits constitute the parent materials of soils on the flood plains of the rivers and drains in the county. Many of these deposits on the lower lying flood plains are reworked from time to time, and new sediments are deposited. There is little soil development, and the horizons are indistinct. There is, however, a textural profile—layers of clay, clay loam, very fine sandy loam, and fine sandy loam. The texture of each layer depends mostly on the speed at which the water was moving at the time the layer was deposited. The sands were deposited when the water moved rapidly, and the clays when the water moved slowly. All the soils on the bottom lands in the county formed in this kind of parent material. They consist of soils in the Lincoln, Miller, Norwood, Port, and Yahola series and the miscellaneous alluvial land types.

### **Climate**

Wilbarger County has a subhumid, warm-temperate, continental type of climate. It is characterized by scanty precipitation in winter, fairly heavy rains late in spring and early in fall, and high winds. Evaporation is high;

and rainwater only occasionally moves completely through the soil. Calcium carbonates have been leached from the upper horizons of most of the soils. The amount of rainfall, however, has not been great enough to leach the carbonates entirely from the soil, and many of the soils have a layer in which calcium carbonates have accumulated. In many of the soils, most of the plant nutrients have been leached from the root zone. Through leaching, the fine clay particles in many soils have been moved down into the subsoil where they have accumulated to form a slowly permeable horizon. The wide variations in temperature have encouraged both the weathering of the underlying rocks and unconsolidated deposits into parent material and the development of soils. The high winds common in many parts of the county have aided in the breakdown of parent material, in reworking many deposits, and in shifting materials from place to place.

### **Relief**

Relief, or lay of the land, helps to determine the kind of soil that develops by affecting the nature of the parent materials accumulated, drainage, the amount and kind of organic matter accumulated in the surface layer, the soil depth, the degree of horizon differentiation, and salinity.

Most of the dark-colored soils in the county occur in slightly concave positions, or depressions, or on broad, nearly level plains. The additional moisture that accumulates in such places aids in the growth of more plants and in their decomposition. Consequently, more organic matter is added to the soil. Biological activity is also increased. Where relief does not encourage excess erosion, soil development will proceed and, in time, some of the shallow soils will become deep soils.

Relief is responsible for the development of the saline soils in the county. In some places, the outwash material is only a thin mantle over the ridges and valleys of the Permian red beds. Because of this, water that is high in soluble salts is pocketed in various places. Eventually, the water rises to the surface and evaporates, and the salts are left as a thin crust on the surface.

### **Living organisms**

All the soils of Wilbarger County formed under grass cover. Short and mid grasses were dominant on the moderately fine textured soils, and tall grasses covered the sandy soils. Large amounts of organic matter were incorporated into the soils from these grasses, chiefly through the decomposition of leaves, stems, and roots by bacteria and other micro-organisms. Roots growing in the soils left them porous and open. Earthworms are the most numerous of the many forms of life that began working and churning the soils once they had been enriched with organic matter. Worm casts and channels occupy as much as 50 to 70 percent of the subsoil in many of the soils. Colonies of prairie dogs, badgers, and moles are also important in reworking and churning the soils.

### **Time**

Time is required for the formation of a mature soil from parent material. An example is the development of Tillman soils from the shales of the Permian red beds, which were laid down some 200 million years ago. The shales weathered to clays; the clays developed into soils like those of the Vernon series, and the Vernonlike soils developed slowly into Tillman soils. This succession occurred where

excessive erosion did not remove the developing soil and the other factors in the environment were at work.

Deep soils that have well-developed, distinct horizons are considered mature. These soils ordinarily are in nearly level or gently sloping positions, and they have been in place for a long time. Deep soils that have indistinct horizons or in which the profile consists of A and C horizons are considered young, or immature. The soils formed in recent alluvium or in eolian materials are good examples of such soils. Similarly, steeply sloping, shallow soils are also young, or immature, even though they have been in place for a long time. Here, geologic erosion resulting from relief has overcome the influence of other factors.

## Classification of the Soils

In the system of soil classification currently followed in the United States, soils are placed in six categories. Beginning at the top, the categories are order, suborder, great soil group, family, series, and type. The categories of suborder and family have not been fully developed, and thus, have been little used (6). In this section, the classification of the soils in Wilbarger County by orders and great soil groups is discussed. The categories of soil series and soil type have been defined in the section "Descriptions of the Soils."

The three soil orders—zonal, intrazonal, and azonal—are represented in Wilbarger County. Zonal soils have well-developed characteristics that reflect the influence of the active factors of soil formation—climate and living organisms, chiefly vegetation. In this county, most of the well-drained soils developed under similar conditions of a warm-temperate, subhumid climate and grass vegetation and have well-defined horizons; thus, they are zonal soils. Three zonal great soil groups are represented: Reddish Brown soils, Chestnut soils, and Reddish Chestnut soils. A great soil group is a grouping of soils having certain major internal characteristics in common.

Reddish Brown soils developed under a cover of bunch-grass and scattered shrubs. They have a surface soil that is typically reddish brown to red and of mellow consistency. The heavier upper subsoil is red or reddish brown and grades to a whitish calcareous horizon. The natural fertility of these soils is relatively low. Soils in the Springer series are in this great soil group.

Chestnut soils developed under a mixed cover of tall grasses and short grasses. The surface soil is dark brown or dark grayish brown. It grades to a lighter colored horizon and finally to a light-gray or white, calcareous horizon at a depth of 18 to 36 inches. The natural fertility is high, but crop growth is limited by the low rainfall and the high rate of evaporation. Soils in the Abilene, Altus, Hollister, and Tipton series are in this great soil group.

Reddish Chestnut soils developed under a mixed grass-shrub cover. The surface soil is dark reddish brown and friable. The upper part of the subsoil is heavier and tougher than the surface soil and is reddish brown to red. The lower part of the subsoil is highly calcareous. The natural fertility of these soils is relatively high, but crop growth is limited by the low rainfall and the high rate of evaporation. Soils in the Cobb, Miles, Tillman, and Wichita series are in this group.

Intrazonal soils have more or less well-developed soil characteristics that reflect the dominating influence of some local factor of relief or parent material over the normal effect of climate and vegetation. Intrazonal soils are represented in Wilbarger County by the shallow soils in the Mansker series, which are in the great soil group of Calcisols (3). Calcisols formed in a warm-temperate to hot, subhumid to semiarid climate; in highly calcareous parent material; and under a sparse stand of short grasses and shrubs. They are only weakly developed. They have a reddish-brown to grayish-brown, friable surface soil and a friable, highly calcareous subsoil. As much as 80 percent, by volume, of the soil mass is calcium carbonate. Mansker soils are shallow, droughty, and low in natural fertility.

Azonal soils are without well-developed soil characteristics, either because of their youth or because conditions of parent material or relief have prevented the development of definite soil characteristics. Three great soil groups of azonal soils are represented in this county: Alluvial soils, Lithosols, and Regosols.

Alluvial soils formed in transported and relatively recent, water-laid deposits (alluvium); the soils are characterized by little or no modification of the original material by soil-forming processes. Soils in the Lincoln, Miller, Norwood, Port, and Yahola series are in this great soil group.

Lithosols have an incomplete solum or no clearly expressed soil morphology; they consist of a freshly and imperfectly weathered mass of hard rock or hard rock fragments and are largely confined to steeply sloping land. In Wilbarger County, they are represented by the highly calcareous soils in the Vernon series.

Regosols consist of deep, unconsolidated rock or soft, mineral deposits in which there are few or no clearly expressed soil characteristics. In Wilbarger County, this group is represented by the sandy soils in the Enterprise and Tivoli series.

The classification of the soils in Wilbarger County by order, great soil group, and series is outlined in the following list.

ZONAL:	AZONAL:
Reddish Brown soils—	Alluvial soils—
Springer.	Lincoln.
Chestnut soils—	Miller.
Abilene.	Norwood.
Altus.	Port.
Hollister.	Yahola.
Tipton.	Lithosols—
Reddish Chestnut soils—	Vernon.
Cobb.	Regosols—
Miles.	Enterprise.
Tillman.	Tivoli.
Wichita.	

INTRAZONAL:
Calcisols—
Mansker.

## Additional Facts About the County

Wilbarger County, named for Josiah and Mathias Wilbarger, was formed in 1858. The present community of Doans is the site of an early settlement near the place where the old cattle trails crossed the Red River. From 1880 to 1890, several hundred thousand head of cattle were

driven from Texas to northern markets. Many of the early settlers came from Arkansas, Tennessee, Georgia, North Carolina, Virginia, and Ohio. Vernon, the county seat, was incorporated in 1889.

In 1960, the total population of the county was 17,748, of which 12,141 persons lived in Vernon. The county is served by two railroads—the Fort Worth and Denver Railway and the Panhandle and Santa Fe Railway. U.S. Highways 287, 283, 183, and 70 cross the county and give access to all the other major roads in the country. There are 12 public schools, 1 church elementary school, and some 40 churches in the county. There are numerous public parks, playgrounds, swimming pools, a golf course, and other recreational facilities.

Most of the industries in the county are located in Vernon. These include a cotton-oil mill, a clothing factory, feed companies, a packing company, athletic equipment companies, three alfalfa mills, and numerous other small plants.

The presence of oil has been important in the growth and economy of the county. There are numerous oil fields throughout the county, and, in 1956, about 1,940 oil wells produced approximately 11,282 barrels daily.

Wilbarger County has an adequate supply of underground water for its domestic and industrial requirements. Water in quantities sufficient for domestic use occurs at a depth of 20 to 50 feet throughout the northern part of the county. Two areas (fig. 13, page 34) have underground water in amounts sufficient for irrigation. The rest of the county depends on other sources for its water supply.

## Agriculture

Cattle ranching was the first agricultural pursuit in the county, since the heavy growth of nutritious grasses made this part of Texas especially well suited to livestock raising. The first bale of cotton was harvested in 1888. Within a few years, wheat became an important crop. By 1910, nearly half the land in the county was in cultivated crops, chiefly cotton and wheat. At the present time, about 45 percent of the county is used for growing cultivated crops and 55 percent is rangeland. In 1954 there were 997 farms in the county; of these farms 427 were more than 260 acres in size, and 202 were more than 500 acres.

Table 7 gives the acreage of the principal crops in three stated years.

TABLE 7.—*Acreage of principal crops in stated years*

Crop	1939	1949	1954
	Acres	Acres	Acres
Wheat threshed or combined-----	26,731	104,742	93,329
Cotton harvested-----	70,159	78,693	60,031
Alfalfa cut for hay-----	3,412	22,242	20,475
Sorghum for all purposes except sirup-----	30,679	14,254	17,519

The number of cattle and calves totaled 40,981 in 1950, and 38,123 in 1954. There are only a few sheep and lambs; the number of these animals has steadily declined from 1,819 in 1940 to 564 in 1954. The number of horses and mules has decreased sharply since 1940, when there were 4,666 in the county. In 1954, there were 1,708 tractors, or more tractors than horses and mules, which totaled 1,304.

## Climate

Wilbarger County has a subhumid, continental climate characterized by scanty precipitation in winter, normally ample rainfall in spring, occasional droughts in summer, and wide variations in temperature. Precipitation is the factor that determines successful crop production. In a period of 47 years, the average annual rainfall at Chillicothe, which is 2 miles west of the county line in Hardeman County, was 24.8 inches (4). The average annual rainfall seldom occurs, however, and more years of below-average rainfall can be expected than years of above-average rainfall. Figure 18 shows that, in 60 percent of the 47 years from 1907 through 1954, rainfall was below average; in 50 percent of the years, rainfall was less than 23.3 inches; and in 25 percent of the years, less than 20.4 inches. Extremely heavy rains of short duration may obscure situations of drought because, although they add to the total amount of rainfall recorded, most of the water runs off and does not penetrate the soil to any depth. On the basis of past records, the probability is that 10 to 20 inches of rainfall may be expected 23 percent of the time; 20 to 30 inches, 60 percent of the time; and more than 40 inches, 4 percent of the time.

Table 8 shows the precipitation at Chillicothe by months. The seasonal pattern shows peaks in May, June, and October. The driest months are January and February.

TABLE 8.—*Precipitation at Chillicothe Station, Hardeman County, Texas*  
[Elevation, 1,406 feet]

Month	Precipitation <sup>1</sup>			
	Average	Driest year (1917)	Wettest year (1941)	Average snowfall
December-----	Inches 1.19	Inches .51	Inches 1.05	Inches 1.5
January-----	.80	.32	1.50	1.9
February-----	.98	.25	2.57	1.6
Winter-----	2.97	1.08	5.12	5.0
March-----	1.40	.40	.80	1.7
April-----	2.56	.75	5.46	.1
May-----	3.37	2.32	12.24	(?)
Spring-----	7.33	3.47	18.50	1.8
June-----	3.43	.22	9.46	0
July-----	2.04	3.12	1.67	0
August-----	2.27	1.44	4.16	(?)
Summer-----	7.74	4.78	15.29	(?)
September-----	2.79	1.02	2.13	0
October-----	2.96	.31	7.25	.1
November-----	1.33	1.12	.49	.4
Fall-----	7.08	2.45	9.87	.5
Year-----	25.12	11.78	48.78	7.3

<sup>1</sup> Average precipitation based on a 50-year record, through 1955; wettest and driest years based on a 47-year record, in the period 1896-1955; snowfall based on a 42-year record, through 1952.

<sup>2</sup> Trace.

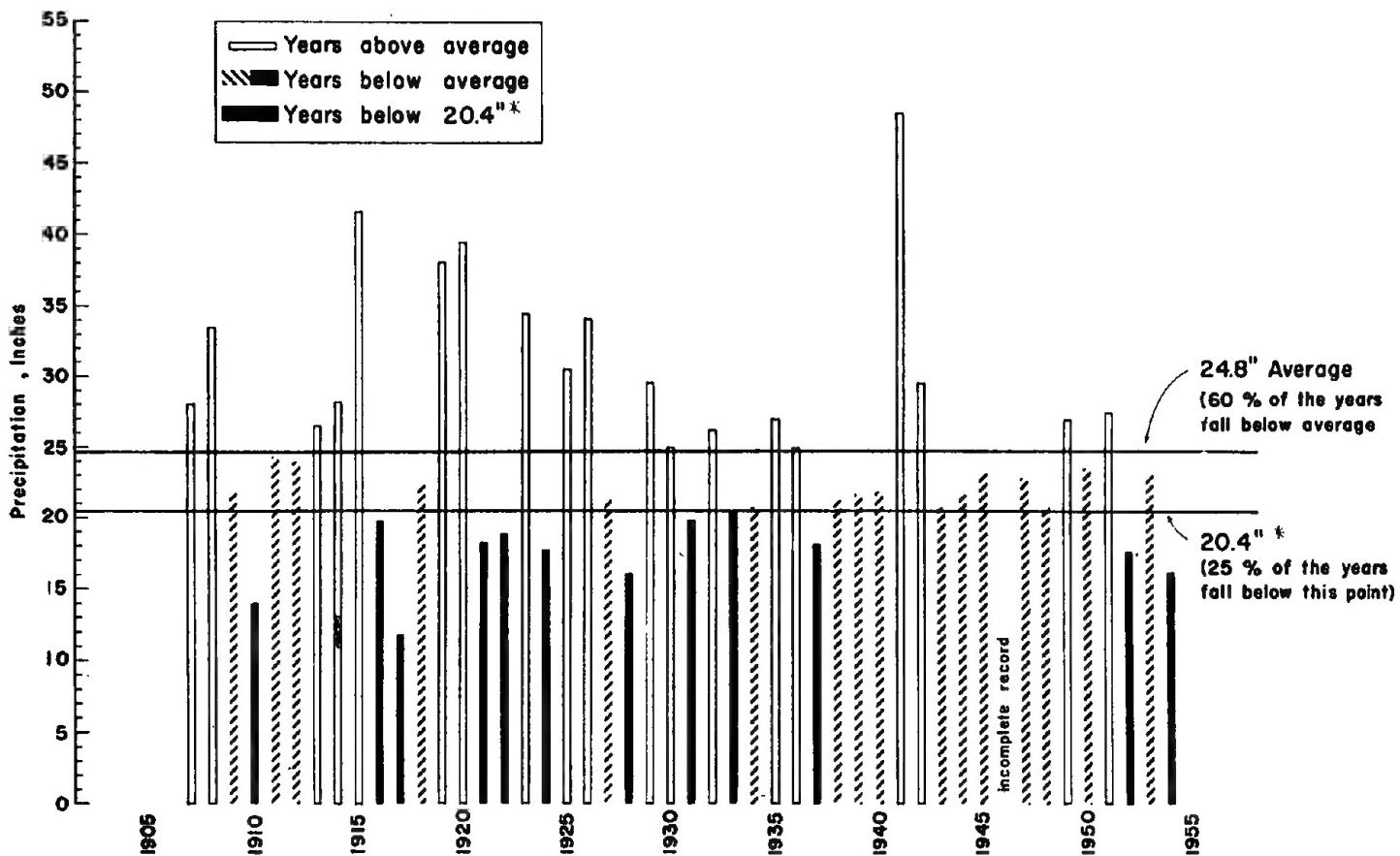


Figure 18.—Annual rainfall at Chillicothe Weather Bureau Station. This figure is reproduced from Texas Agricultural Experiment Station Miscellaneous Publication 154 (4).

The average maximum temperature is about 80° F., and the average minimum temperature, 57° F., but maximum temperatures of 119° F. and minimum temperatures of -9° F. have been recorded. The average length of the growing season at Quanah, near Chillicothe, is 224 days, from March 28 to November 9. In winter, the soils freeze to a depth of only a few inches.

Winds generally blow from the southwest at 2 to 12 miles per hour, though there are occasional gusts of 35 miles per hour. These winds quickly evaporate surface moisture (2) and further damage crop fields by blowing the soil. Young plants are burned by the wind and covered by blowing soil. March is the month of highest winds. In spring, cool fronts from the northwest bring thunderstorms and high winds of as much as 75 miles per hour. Tornadoes are a threat in May, June, and July, although very few actually touch ground.

## Glossary

**Aggregate, soil.** Many fine soil particles held together in a single mass or cluster, such as a crumb, block, or prism. Many properties of the aggregate differ from those of an equal mass of unaggregated soil.

**Alluvium.** Soil materials, such as gravel, sand, silt, and clay, deposited on land by streams.

**Calcareous soil.** A soil containing enough calcium carbonate to effervesce (fizz) when treated with dilute hydrochloric acid.

**Clay.** (1) As a soil separate, mineral soil particles less than 0.002 millimeter (0.000079 inch) in diameter. (2) As a soil textural class, soil material that is 40 percent or more clay as defined under (1), less than 45 percent sand, and less than 40 percent silt.

**Claypan.** A compact, slowly permeable soil horizon that is rich in clay and is separated more or less abruptly from the overlying soil. Claypans commonly are hard when dry and plastic or stiff when wet.

**Claypan.** A compact, slowly permeable soil horizon that is rich in clay and is separated more or less abruptly from the overlying soil. Claypans commonly are hard when dry and plastic or stiff when wet.

**Concretions.** Hard grains, pellets, or nodules that are formed by the local concentration of certain compounds, such as calcium carbonate and iron and manganese oxides, in the soil. They have various shapes, sizes, and colors.

**Consistence, soil.** The combination of properties of soil material that determines its resistance to crushing and its ability to be molded or changed in shape. Consistence depends mainly on the strength and nature of the forces of attraction between soil particles. It varies widely with differences in moisture content; thus, a soil aggregate, or clod, may be hard when dry and plastic when wet.

Terms used to describe consistence when the soil is wet are—

**Plastic.** Soil material is easily rolled between thumb and forefinger into a wire or thin rod of soil without breaking; moderate pressure is required to deform the soil mass. Plastic soils are high in clay and are difficult to till.

**Sticky.** Soil material adheres to thumb and forefinger after pressure.

Terms used to describe consistence when the soil is moist are—

**Firm.** Soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable. Firm soils are likely to be difficult to till.

**Friable.** Soil material crushes easily under gentle to moderate pressure between thumb and forefinger and coheres when pressed together. Friable soils are easily tilled.

**Loose.** Noncoherent when moist or dry. Loose soils are generally coarse textured and easily tilled.

Terms used to describe consistence when the soil is dry are—

**Hard.** Soil material is moderately resistant to pressure; it can be broken in the hands without difficulty but is barely breakable between thumb and forefinger.

**Soft.** Soil material is very weakly coherent and fragile and breaks to powder or individual grains under very slight pressure.

**Convex slope.** A land surface that is curved like the exterior of a sphere or arch.

**Dune.** A mound or ridge of loose sand piled up by the wind. In this county, dunes generally are less than 10 feet high and have a gradient of more than 8 percent.

**Field moisture equivalent.** The minimum moisture content at which a smooth surface of soil will absorb no more water in 30 seconds when the water is added in individual drops. It is the moisture content required to fill all the pores in sands and to approach saturation in cohesive soils.

**Gravel.** A soil separate, rounded or angular, having a diameter ranging from 2.0 millimeters to 80 millimeters. The content of gravel is not used in determining the textural class of the soil, but, if the soil is 20 percent or more gravel, the word "gravelly" is added to the textural soil name.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes and that differs in one or more ways from adjacent horizons in the same profile. The relative positions of the several soil horizons in the soil profile and their designations are—

**A horizon.** The master horizon consisting of (1) one or more mineral horizons of maximum organic accumulation; or (2) surface or subsurface horizons that are lighter in color than the underlying horizon and have lost clay minerals, iron, and aluminum, with resultant concentration of the more resistant minerals; or (3) horizons belonging to both of these categories.

**B horizon.** The master horizon of altered material characterized by (1) an accumulation of clay, iron, or aluminum, with accessory organic matter; or (2) blocky or prismatic structure together with other characteristics, such as stronger colors, unlike those of the A horizon or the underlying horizons of nearly unchanged material; or (3) characteristics of both these categories. Commonly, the lower limit of the B horizon corresponds with the lower limit of the solum.

**C horizon.** A layer of unconsolidated material, relatively little affected by organisms and presumed to be similar in chemical, physical, and mineralogical composition to the material from which at least a part of the solum has developed.

**D horizon.** Any stratum underlying the C horizon, or the B if no C is present, which is unlike the C horizon or unlike the material from which the solum has been formed.

**Any major horizon (A, B, C, or D)** may or may not consist of two or more subdivisions or subhorizons, and each subhorizon in turn may or may not have subdivisions. For the kinds of subdivisions that may exist, along with their designations and definitions, the reader is referred to the Soil Survey Manual (8).

**Hummocky.** Of topography, irregular or choppy and having small dunes or mounds that are 3 to 10 feet high and have a gradient of 3 to 8 percent.

**Lineal shrinkage.** The decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the stipulated percentage to the shrinkage limit.

**Liquid limit.** The moisture content at which a soil passes from a plastic to a liquid state, expressed in percentage.

**Loam.** The textural class name for a soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

**Outwash.** Crossbedded gravel, sand, silt, and clay deposited by melt water as it flowed from glacial ice; overwash. In this county, outwash refers to soil material that was washed from

areas in the High Plains and Rocky Mountains by melt water, carried in streams, and deposited on the Permian red beds during the Pleistocene epoch.

**Parent material.** The weathered or partly weathered, unconsolidated mass of rock material from which the soil develops.

**Permeability, soil.** The quality of the soil that enables it to transmit air and water. The permeability of the soil may be limited by the presence of one nearly impermeable horizon, even though the others are permeable. Moderately permeable soils transmit air and water readily, a condition that is favorable for the growth of roots. Slowly permeable soils allow water and air to move so slowly that root growth is restricted. Rapidly permeable soils transmit air and water rapidly, and root growth is good.

**pH.** A numerical designation of the relative acidity and alkalinity of soils and other biological systems. Technically, pH is the common logarithm of the reciprocal of the hydrogen-ion concentration of a solution. A pH of 7.0 indicates precise neutrality; higher values indicate increasing alkalinity, and lower values indicate increasing acidity. (See also Reaction, soil.)

**Plastic limit.** The moisture content at which a soil changes from a semisolid to a plastic state; that is, a state in which it is capable of being deformed or rolled into threads, one-eighth inch in diameter, without breaking.

**Plasticity index.** The numerical difference between the plastic limit and the liquid limit; thus, the range in moisture content through which the soil remains plastic.

**Profile, soil.** A vertical section of the soil through all its horizons and extending into the parent material.

**Poorly graded soil (engineering).** A soil consisting of particles chiefly of the same, or very nearly the same, size or diameter; such a soil has a narrow range of particle size and, thus, poor grain-size distribution. Density of such a soil can be increased only slightly by compaction.

**Reaction, soil.** The degree of acidity or alkalinity of a soil mass, expressed either in pH value or in words, as follows:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

**Relief.** The elevations or inequalities of a land surface, considered collectively; also, the difference in elevation between the hilltops, or summits, and the lowlands of a region.

**Residual material.** Unconsolidated and partly weathered parent material presumed to have developed from the same kind of rock as that on which it lies (also referred to as residuum).

**Saline soil.** A soil containing enough soluble salts to impair its productivity for plants but not containing an excess of exchangeable sodium.

**Sand.** (1) Individual rock or mineral fragments having a diameter of 0.05 millimeter (0.002 inch) to 2.0 millimeters (0.079 inch). Sand grains consist chiefly of quartz, but they may be of any mineral composition. (2) As a textural class, any soil that is 85 percent or more sand and not more than 10 percent clay.

**Shrinkage limit.** The moisture content of the soil at the point where, as moisture leaves the soil, shrinkage stops even though additional moisture is removed.

**Shrinkage ratio.** The ratio between the volume change, expressed as a percentage of the volume of the dry soil pat, and the corresponding loss of moisture above the shrinkage limit, expressed as a percentage of the weight of the dry soil pat.

**Shrink-swell potential.** The ability of a soil to lose volume, or shrink, with a loss in water content and to gain volume, or swell, with an increase in water content.

**Silt.** (1) As a soil separate, individual mineral particles that range in diameter from 0.05 millimeter (0.00197 inch) to 0.002 millimeter (0.000079 inch). (2) As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

**Slickspots.** A local term used to describe alkali spots.

**Soil separate.** The individual size groups of soil particles, such as sand, silt, and clay; ordinarily, particles larger than 2 millimeters in diameter are not included.

**Soil slope.** The incline of the surface of a soil. It is generally expressed in percentage, which equals the number of feet of fall per 100 feet of horizontal distance.

**Solum.** The genetic soil developed by soil-forming processes; the upper part of the soil profile, the A and B horizons, above the parent material, or C horizon. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

**Structure, soil.** The arrangement of the individual soil particles into aggregates that have definite shape and pattern. Structure is described in terms of grade—*weak, moderate, and strong*, that is, the degree of distinctiveness and durability of the aggregates; by class—*very fine or very thin, fine or thin, medium, coarse or thick, and very coarse or very thick*, that is, the size of the aggregates; and by type or shape—*blocky, subangular blocky, columnar, crumb, granular, platy, and prismatic*. *Structureless* is that condition in which there are no observable aggregates or no definite orderly arrangement of natural lines of weakness—*massive* if coherent and *single grain* if noncoherent.

**Blocky, angular.** The particles are arranged around a point and are bounded by flat or rounded surfaces that are casts of the molds formed by the faces of surrounding peds; the aggregates are shaped like blocks. In angular blocky structure, the surfaces join at sharp angles. If the term "blocky" is used alone, angular blocky is understood.

**Blocky, subangular.** The aggregates have some rounded and some flat surfaces; the upper faces are rounded.

**Columnar.** The particles are arranged around a vertical line and are bounded by relatively flat surfaces; the height of the aggregates is greater than the width, and the upper ends are rounded.

**Crumb.** The particles are arranged around a point into aggregates that are irregular but tend toward a spherical shape; the aggregates are soft, small, and porous.

**Granular.** The aggregates are roughly spherical, firm, and small; they may be either hard or soft but generally are more firm and less porous than crumb and are without the distinct faces of blocky structure.

**Platy.** The particles are arranged around a plane, generally horizontal; the aggregates are flaky or platelike.

**Prismatic.** The particles are arranged around a vertical line and are bounded by flat surfaces; the upper ends are not rounded.

**Subsoil.** Technically, the B horizon of a soil that has distinct horizons. In more general terms, that part of the soil profile below plow depth in which roots normally grow.

**Substratum.** Any layer lying beneath the solum, or true soil. The term is applied both to parent material and to other layers unlike the parent material that lie below the B horizon or the subsoil.

**Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches thick.

**Texture, soil.** The relative proportions of the various size groups of individual soil grains in a mass of soil; specifically, the proportions of sand, silt, and clay. Soil textural classes named in classifying the soils in this county are *fine sand, loamy fine sand, sandy loam, fine sandy loam, very fine sandy loam, loam, silt loam, clay loam, and clay*.

**Topsoil (engineering and landscaping).** Presumably fertile soil material, rich in organic matter, that is used to topdress road-banks, lawns, and gardens.

**Undulating.** Of topography, rising or falling like waves; characterized by a rhythmic succession of wavelike crests and hollows, or of higher and lower levels. In this county, the rises are less than 5 feet high and have a gradient of less than 3 percent.

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## GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

See table 1, page 6, for the approximate acreage and proportionate extent of the soils. See tables 4, 5, and 6, pages 46, 50, 54, for information on the engineering properties of the soils. In some of the capability units, crops are irrigated part of the time; the capability classification and management under irrigation for these units are given on the same pages as the management for dryfarming.

Map symbol	Mapping unit	Capability units			Range sites	
		Page	Unit	Page	Site	Page
AbA	Abilene clay loam, 0 to 1 percent slopes	7	IIC-1	27	Deep Hardland	38
AbB	Abilene clay loam, 1 to 3 percent slopes	8	IIC-1	27	Deep Hardland	38
Ak	Abilene-slickspot complex	8	IIIS-1	30	Deep Hardland	38
Am	Altus fine sandy loam	9	IIC-3	27	Mixed Land	39
Ap	Altus fine sandy loam, poorly drained variant	9	IIIw-1	30	Mixed Land	39
As	Altus loamy fine sand	9	IIIe-7	29	Sandy Land	38
CoB	Cobb fine sandy loam, 1 to 3 percent slopes	9	IIIe-3	29	Mixed Land	39
Cs	Cobb fine sandy loam, shallow variant	10	IVe-6	31	Mixed Land	39
EfA	Enterprise fine sandy loam, 0 to 1 percent slopes	11	IIC-4	28	Mixed Land	39
EfB	Enterprise fine sandy loam, 1 to 3 percent slopes	11	IIIe-4	29	Mixed Land	39
EnA	Enterprise very fine sandy loam, 0 to 1 percent slopes	10	I-1	26	Mixed Land	39
EnB	Enterprise very fine sandy loam, 1 to 3 percent slopes	10	IIC-2	27	Mixed Land	39
EnC	Enterprise very fine sandy loam, 3 to 5 percent slopes	11	IIIe-2	28	Mixed Land	39
EnD	Enterprise very fine sandy loam, 5 to 8 percent slopes	11	IVe-2	31	Mixed Land	39
HcA	Hollister clay loam, 0 to 1 percent slopes	12	IIC-1	27	Deep Hardland	38
HcB	Hollister clay loam, 1 to 3 percent slopes	12	IIC-1	27	Deep Hardland	38
Ln	Lincoln loamy fine sand	13	IVe-4	31	Bottom Land	37
Lo	Loamy alluvial land	13	Vw-1	32	Bottom Land	37
MaB	Mansker loam, 1 to 3 percent slopes	13	IIIe-6	29	Mixed Land	39
MaC	Mansker loam, 3 to 5 percent slopes	14	IVe-6	31	Mixed Land	39
MaD	Mansker loam, 5 to 8 percent slopes	14	VIe-1	32	Mixed Land	39
MfA	Miles fine sandy loam, 0 to 1 percent slopes	14	IIC-3	27	Mixed Land	39
MfB	Miles fine sandy loam, 1 to 3 percent slopes	15	IIC-3	27	Mixed Land	39
MfC	Miles fine sandy loam, 3 to 5 percent slopes	15	IIIe-3	29	Mixed Land	39
MfC2	Miles fine sandy loam, 2 to 5 percent slopes, eroded	15	IVe-3	31	Mixed Land	39
MfD	Miles fine sandy loam, 5 to 8 percent slopes	15	VIe-1	32	Mixed Land	39
MmB	Miles loamy fine sand, 0 to 3 percent slopes	15	IIIe-5	29	Sandy Land	38
MmC	Miles loamy fine sand, 3 to 5 percent slopes	15	IVe-5	31	Sandy Land	38
Mr	Miller clay	16	IIIS-2	30	Bottom Land	37
Mt	Miller clay loam	16	IIC-1	27	Bottom Land	37
Nc	Norwood clay loam	16	I-1	26	Bottom Land	37
No	Norwood silt loam	17	I-1	26	Bottom Land	37
Ow	Oil-waste land	17	VIIIs-1	32	Rough Breaks	40
Pc	Port clay loam	18	I-1	26	Bottom Land	37
Rb	Rough broken land, clayey	18	VIIIs-1	32	Rough Breaks	40
Ro	Rough broken land, loamy	18	VIe-1	32	Mixed Land	39
Sa	Sandy alluvial land	18	Vw-1	32	Bottom Land	37
Sg	Springer loamy fine sand, hummocky	19	VIc-2	32	Sandy Land	38
Sp	Springer loamy fine sand, undulating	19	IVe-4	31	Sandy Land	38
TcA	Tillman clay loam, 0 to 1 percent slopes	20	IIIs-1	28	Deep Hardland	38
TcB	Tillman clay loam, 1 to 3 percent slopes	20	IIIe-1	28	Deep Hardland	38
TcB2	Tillman clay loam, 1 to 3 percent slopes, eroded	20	IVe-1	30	Deep Hardland	38
TpA	Tipton silt loam, 0 to 1 percent slopes	21	I-1	26	Mixed Land	39
TpB	Tipton silt loam, 1 to 3 percent slopes	21	IIC-2	27	Mixed Land	39
Tv	Tivoli fine sand	21	VIIC-1	32	Sandy Land	38
VcC	Vernon clay loam, 2 to 5 percent slopes	22	VIe-3	32	Shallow Hardland	39
Vx	Vernon complex	22	VIc-3	32	Shallow Hardland	39
WcA	Wichita clay loam, 0 to 1 percent slopes	23	IIC-1	27	Deep Hardland	38
WcB	Wichita clay loam, 1 to 3 percent slopes	24	IIC-1	27	Deep Hardland	38
WmA	Wichita loam, 0 to 1 percent slopes	24	IIC-1	27	Mixed Land	39
Ya	Yahola very fine sandy loam	24	I-1	26	Bottom Land	37







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program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

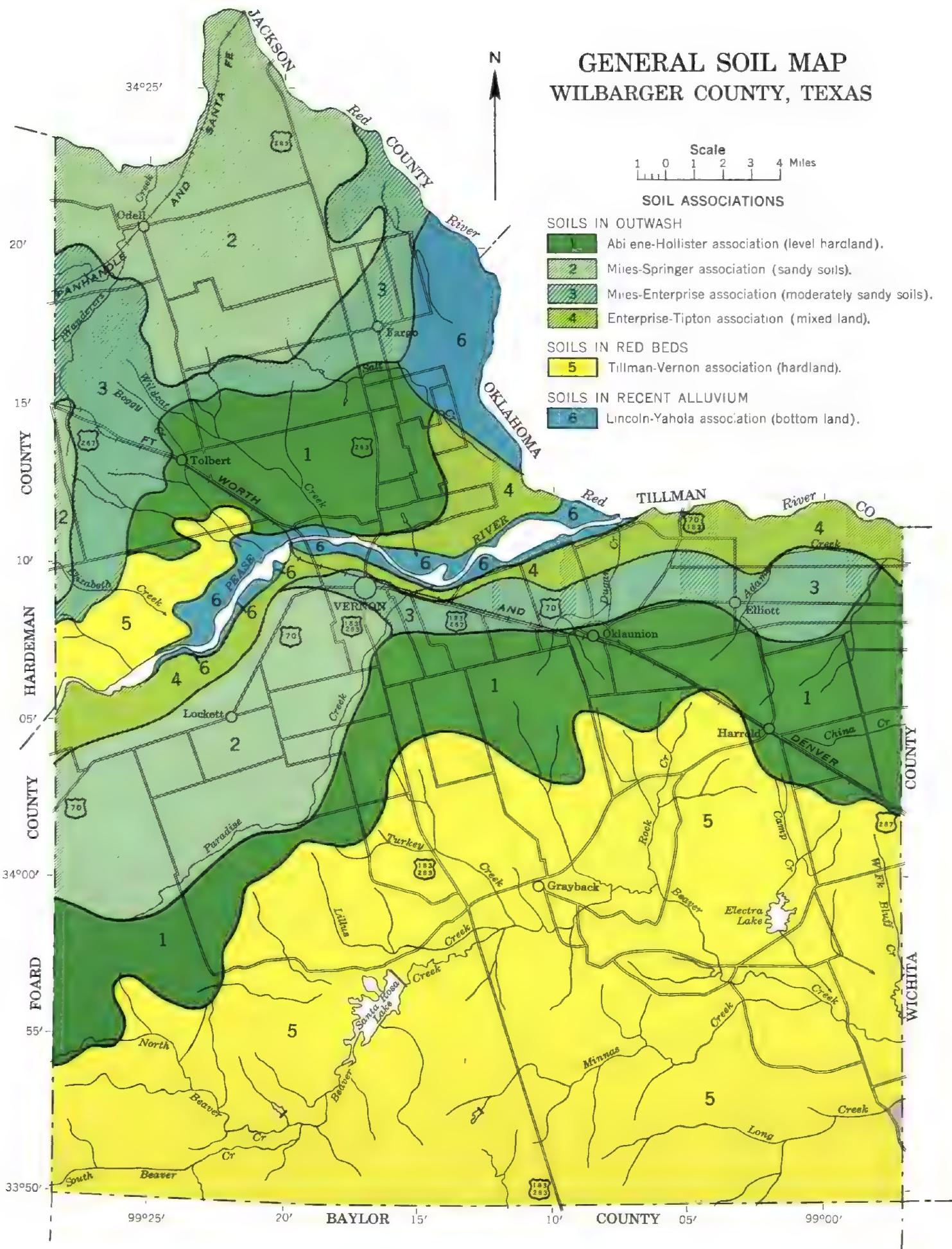
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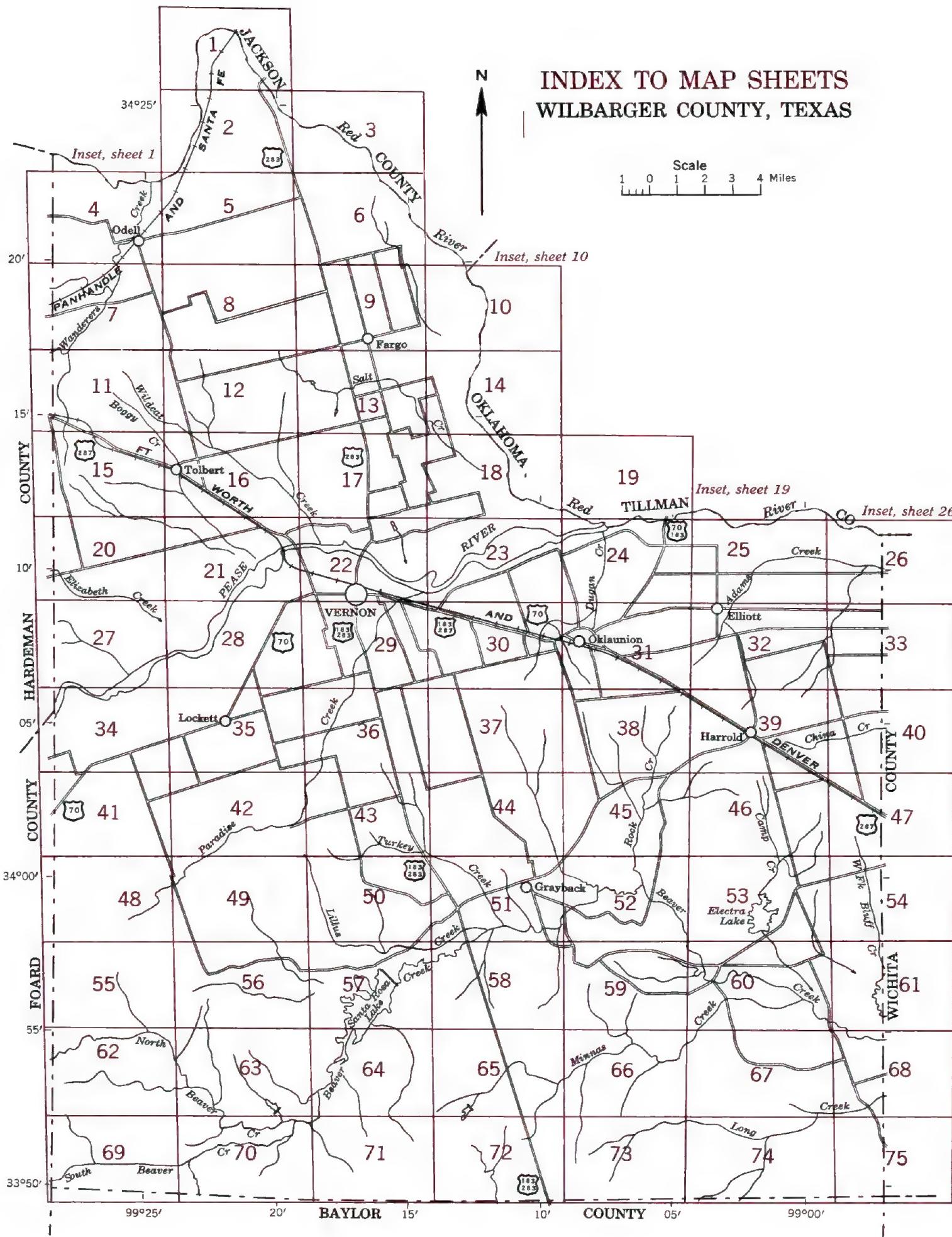
**All Other Inquiries**

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (<http://directives.sc.egov.usda.gov/33086.wba>).

**GENERAL SOIL MAP  
WILBARGER COUNTY, TEXAS**



# INDEX TO MAP SHEETS WILBARGER COUNTY, TEXAS



## SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, or D, shows the slope. Most symbols without a slope letter are those of nearly level soils, such as Miller clay, but some are for land types, such as Rough broken land, loamy, that have a considerable range of slope. Soils that are named as eroded have a final number, 2, in their symbol.

SYMBOL	NAME
AbA	Abilene clay loam, 0 to 1 percent slopes
AbB	Abilene clay loam, 1 to 3 percent slopes
Ak	Abilene-slickspot complex
Am	Altus fine sandy loam
Ap	Altus fine sandy loam, poorly drained variant
As	Altus loamy fine sand
CoB	Cobb fine sandy loam, 1 to 3 percent slopes
Cs	Cobb fine sandy loam, shallow variant
EfA	Enterprise fine sandy loam, 0 to 1 percent slopes
EfB	Enterprise fine sandy loam, 1 to 3 percent slopes
EnA	Enterprise very fine sandy loam, 0 to 1 percent slopes
EnB	Enterprise very fine sandy loam, 1 to 3 percent slopes
EnC	Enterprise very fine sandy loam, 3 to 5 percent slopes
EnD	Enterprise very fine sandy loam, 5 to 8 percent slopes
HcA	Hollister clay loam, 0 to 1 percent slopes
HcB	Hollister clay loam, 1 to 3 percent slopes
Ln	Lincoln loamy fine sand
Lo	Loamy alluvial land
MaB	Mansker loam, 1 to 3 percent slopes
MaC	Mansker loam, 3 to 5 percent slopes
MaD	Mansker loam, 5 to 8 percent slopes
MfA	Miles fine sandy loam, 0 to 1 percent slopes
MfB	Miles fine sandy loam, 1 to 3 percent slopes
MfC	Miles fine sandy loam, 3 to 5 percent slopes
MfC2	Miles fine sandy loam, 2 to 5 percent slopes, eroded
MfD	Miles fine sandy loam, 5 to 8 percent slopes
MmB	Miles loamy fine sand, 0 to 3 percent slopes
MmC	Miles loamy fine sand, 3 to 5 percent slopes
Mr	Miller clay
Mt	Miller clay loam
Nc	Norwood clay loam
No	Norwood silt loam
Ow	Oil-waste land
Pc	Port clay loam
Rb	Rough broken land, clayey
Ro	Rough broken land, loamy
Sa	Sandy alluvial land
Sg	Springer loamy fine sand, hummocky
Sp	Springer loamy fine sand, undulating
TcA	Tillman clay loam, 0 to 1 percent slopes
TcB	Tillman clay loam, 1 to 3 percent slopes
TcB2	Tillman clay loam, 1 to 3 percent slopes, eroded
TpA	Tipton silt loam, 0 to 1 percent slopes
TpB	Tipton silt loam, 1 to 3 percent slopes
Tv	Tivoli fine sand
VcC	Vernon clay loam, 2 to 5 percent slopes
Vx	Vernon complex
WcA	Wichita clay loam, 0 to 1 percent slopes
WcB	Wichita clay loam, 1 to 3 percent slopes
WmA	Wichita loam, 0 to 1 percent slopes
Ya	Yahola very fine sandy loam

Soil map constructed 1962 by Cartographic Division,  
Soil Conservation Service, USDA, from 1956 aerial  
photographs. Controlled mosaic based on Texas  
plane coordinate system, north central zone, Lambert  
Conformal conic projection, 1927 North American  
datum.

## CONVENTIONAL SIGNS

## WORKS AND STRUCTURES

Highways and roads	
Dual	=====
Good motor	=====
Poor motor	=====
Trail	- - - - -
Highway markers	
National Interstate	○
U. S.	○
State	○
Railroads	
Single track	—+—+—+—
Multiple track	—#—#—#—#—
Abandoned	—+—+—+—
Bridges and crossings	
Road	—+—+—+—
Trail, foot	—+—+—+—
Railroad	—+—+—+—
Ferries	—+—+—+—
Ford	—+—+—+—
Grade	—+—+—+—
R. R. over	—+—+—+—
R. R. under	—+—+—+—
Tunnel	—+—+—+—
Buildings	
School	■
Church	●
Station	—+—+—+—
Mines and Quarries	✖
Mine dump	■■■■
Pits, gravel or other	✖
Power lines	- - - - -
Pipe lines	—+—+—+—
Cemeteries	□
Dams	—+—+—+—
Levees	—+—+—+—
Tanks	● ●
Oil wells	●

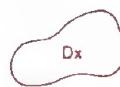
## DRAINAGE

Streams	
Perennial	..
Intermittent, unclass.	..
Canals and ditches	
CANAL	—+—+—+—
DITCH	—+—+—+—
Lakes and ponds	
Perennial	○
Intermittent	○
Wells	○ → flowing
Springs	○
Marsh	—+—+—+—
Wet spot	○

## RELIEF

Escarpments	
Bedrock	vvvvvvvvvvvvvvvv
Other	—+—+—+—
Prominent peaks	○
Depressions	
Crossable with tillage implements	○
Not crossable with tillage implements	○
Contains water most of the time	○

## SOIL SURVEY DATA



Soil boundary  
and symbol

Gravel

Stones

Rock outcrops

Chert fragments

Clay spot

Sand spot

Gumbo or scabby spot

Made land

Severely eroded spot

Blowout, wind erosion

Gullies

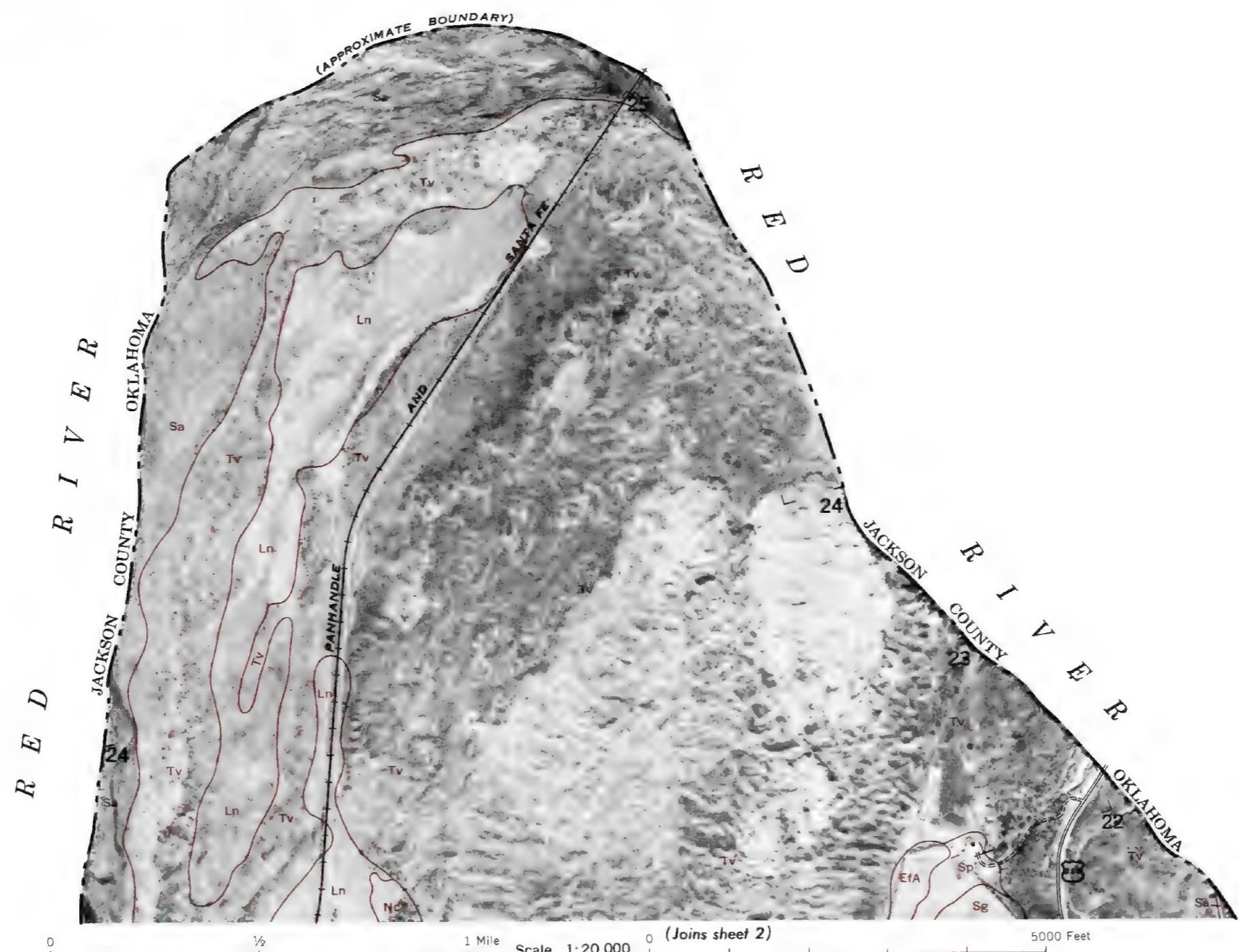
Saline spot

WILBARGER COUNTY, TEXAS - SHEET NUMBER 1

1



(Joins sheet 4)

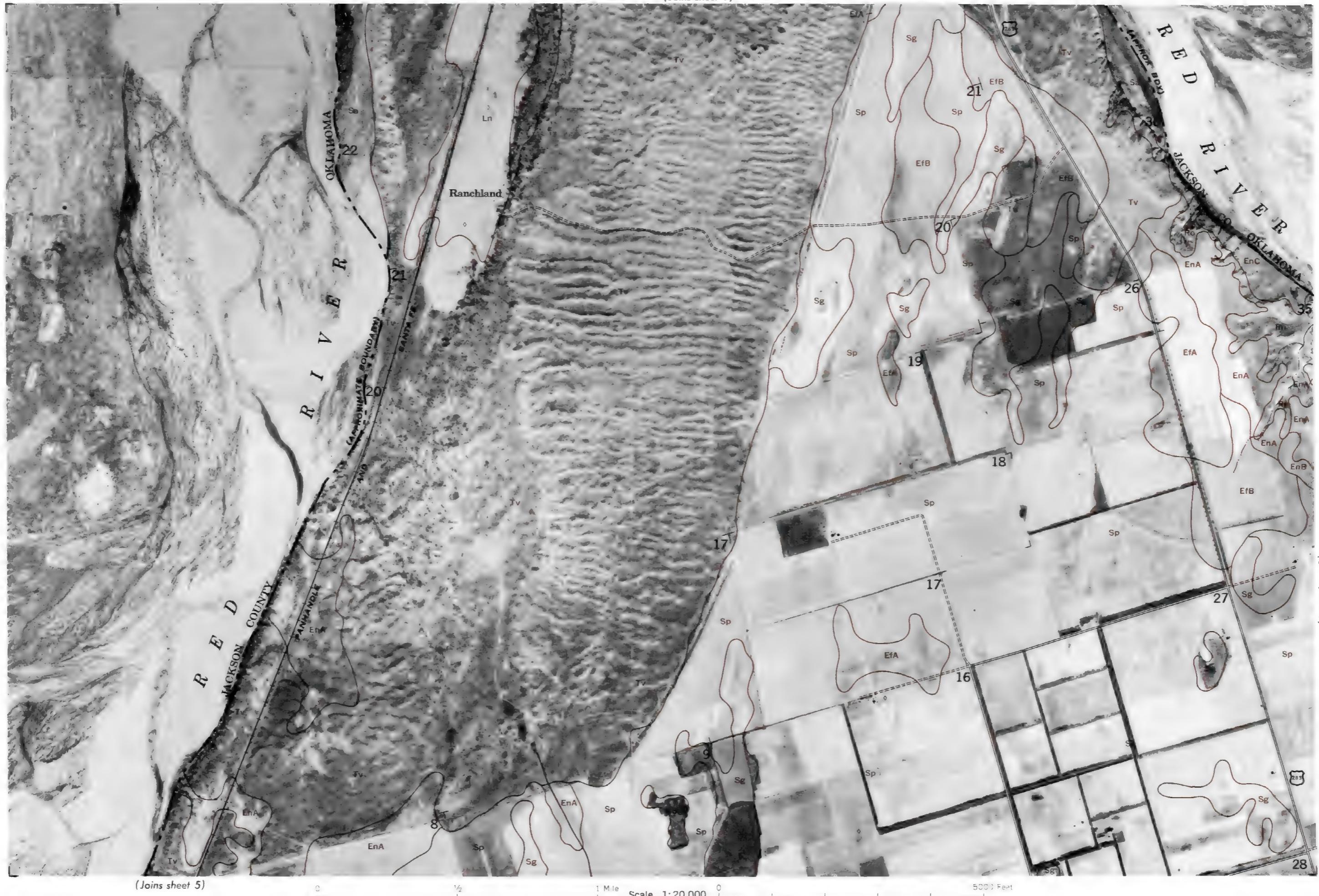


0 1/2 1 Mile Scale 1:20 000 (Joins sheet 2)

5000 Feet

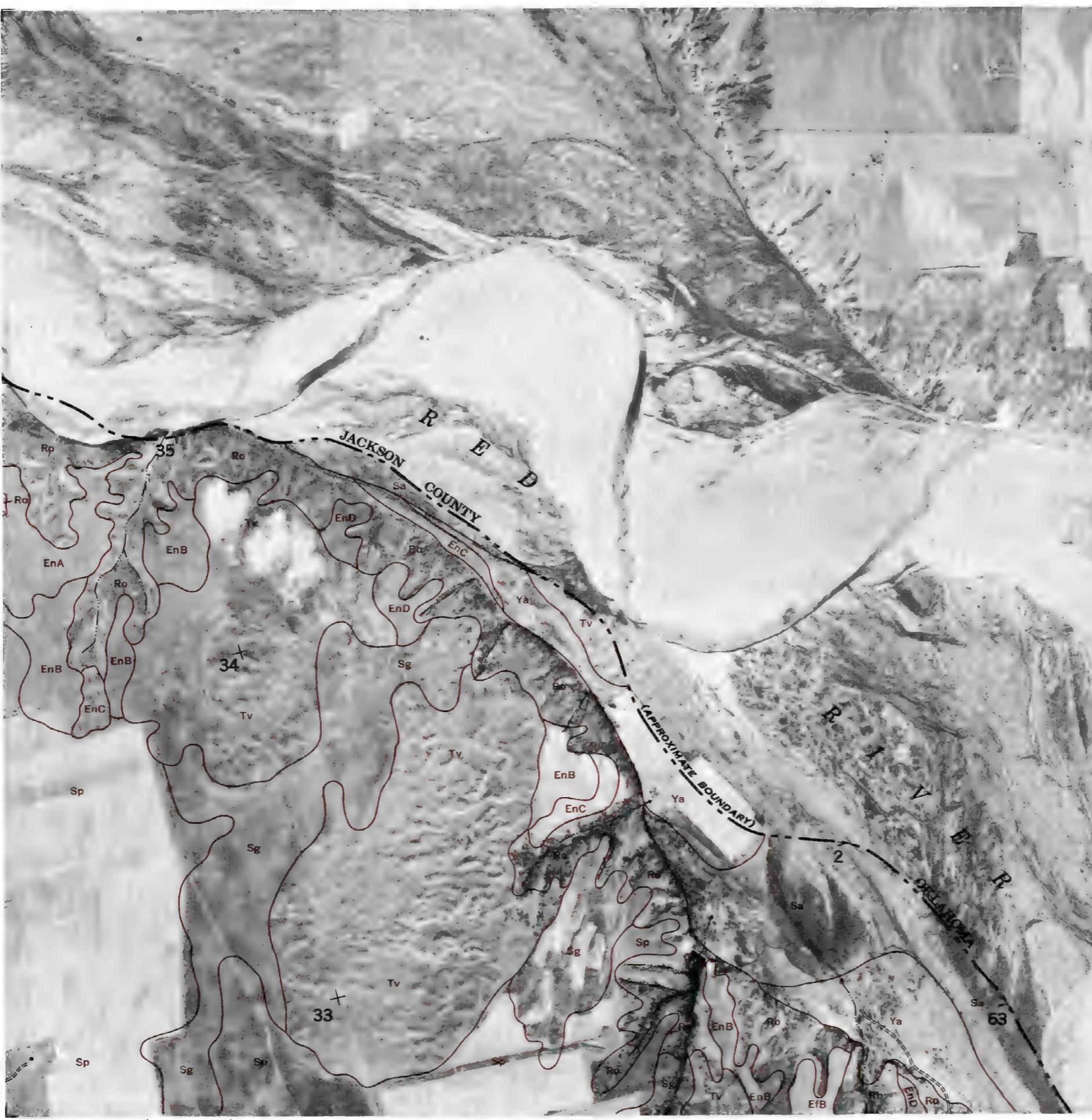
Land divisions and numbers shown on this map are indefinite.

2



WILBARGER COUNTY, TEXAS - SHEET NUMBER 3

3



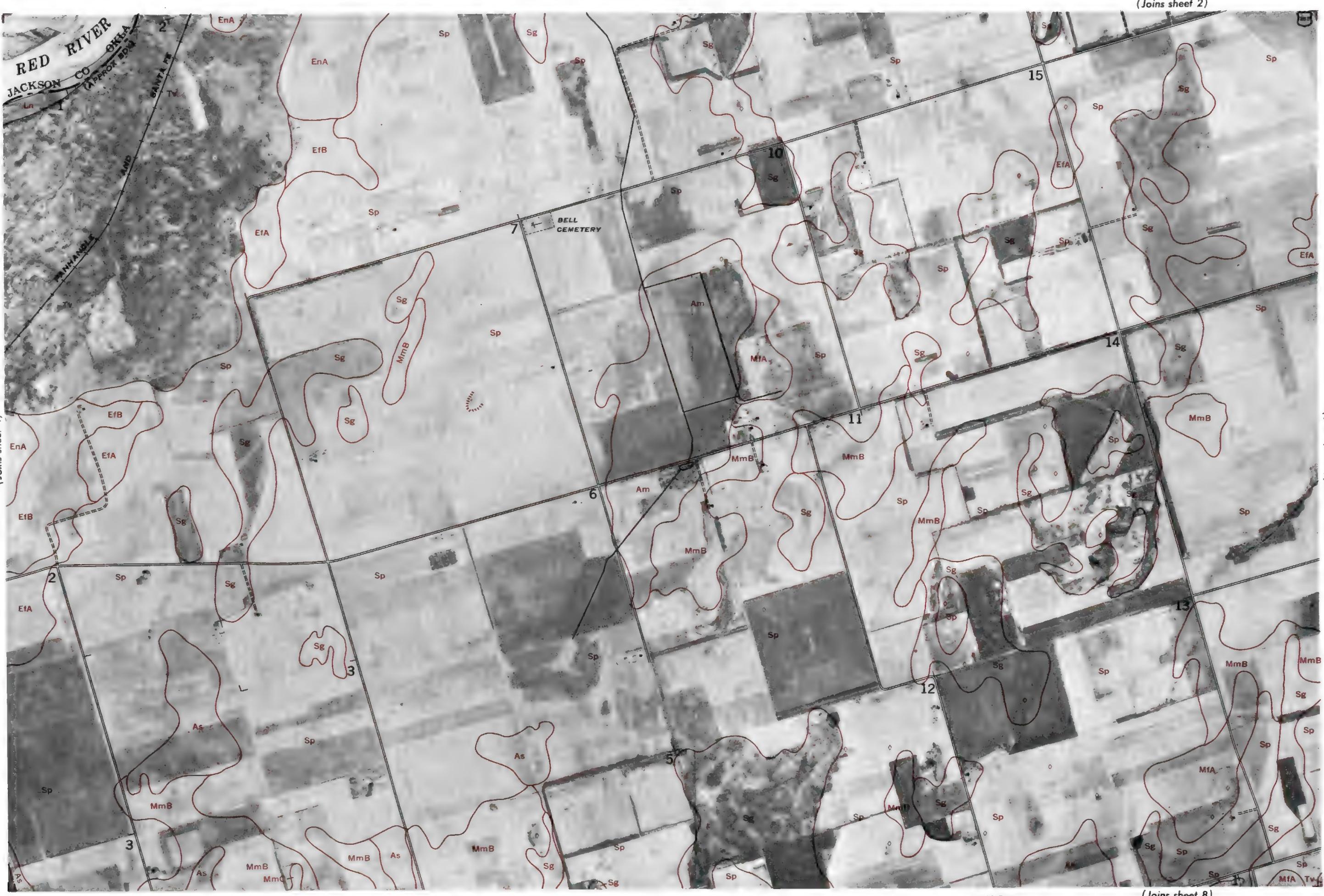
## WILBARGER COUNTY, TEXAS - SHEET NUMBER 4

4

N



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 5



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

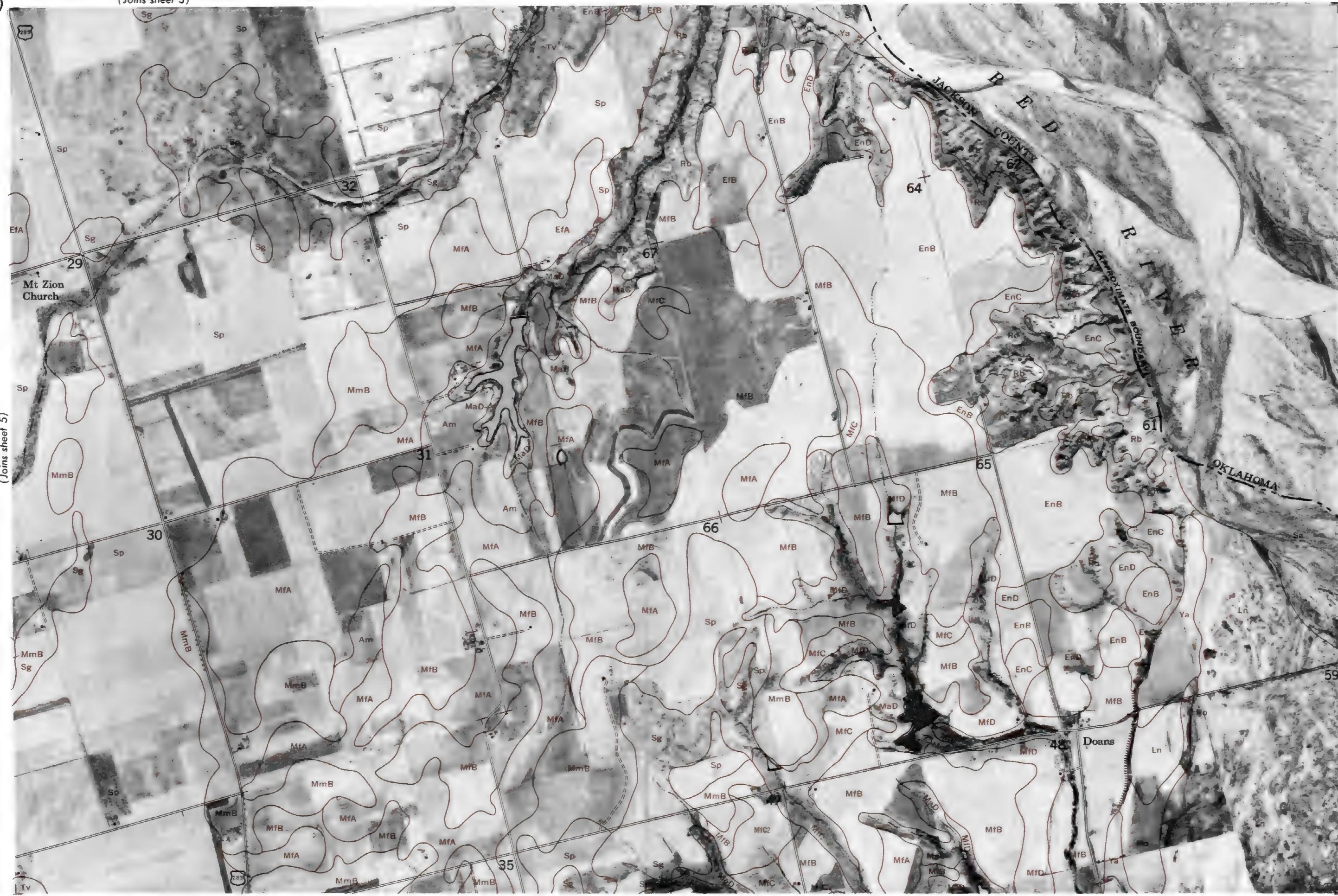
Land division corners and numbers shown on this map are indefinite.

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 6

6

N

(Joins sheet 3)



(Joins sheet 5)

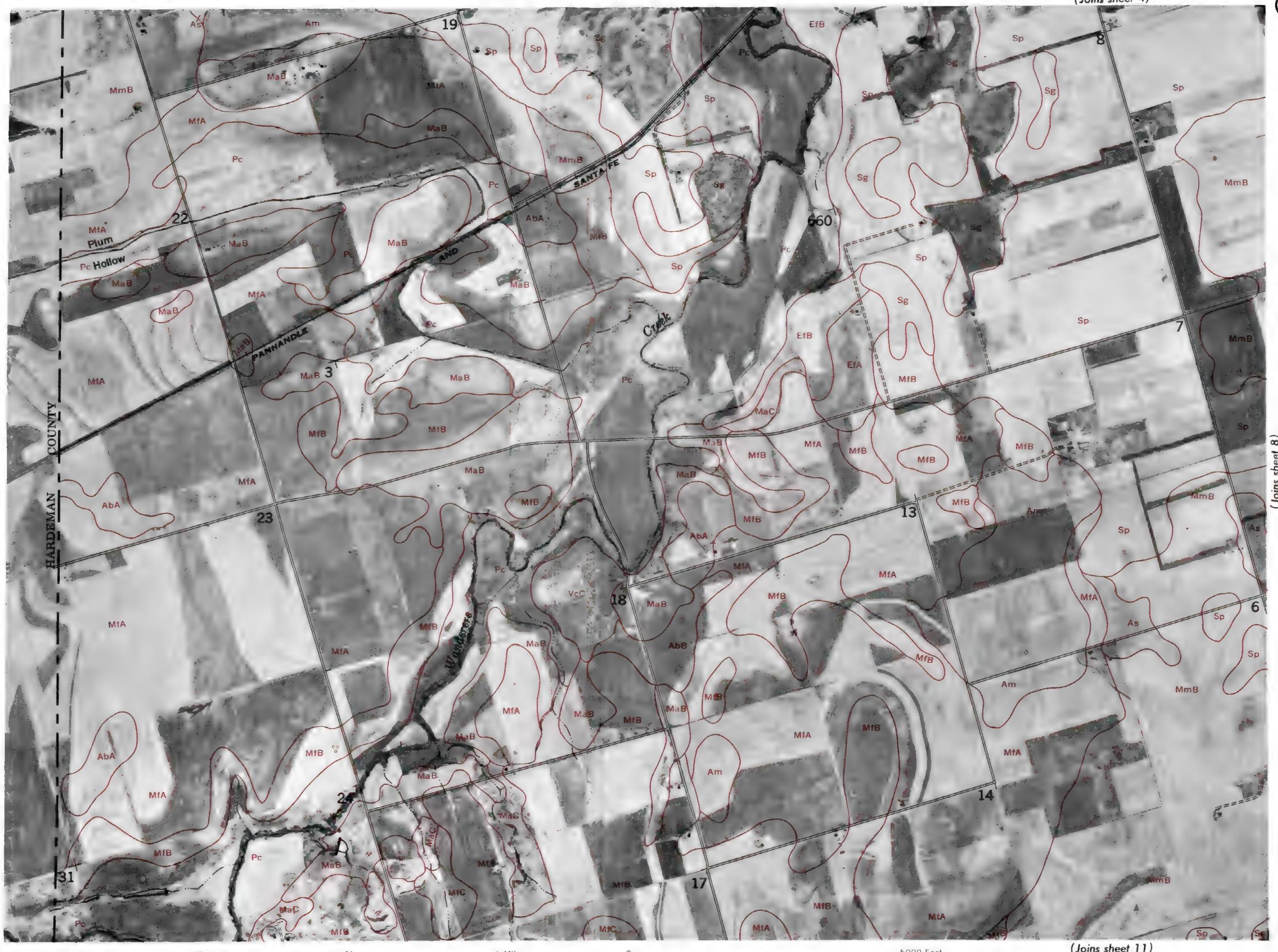
(Joins sheet 9)

(Joins inset, sheet 10)

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 7

(Joins sheet 4)

7



(Joins sheet 8)

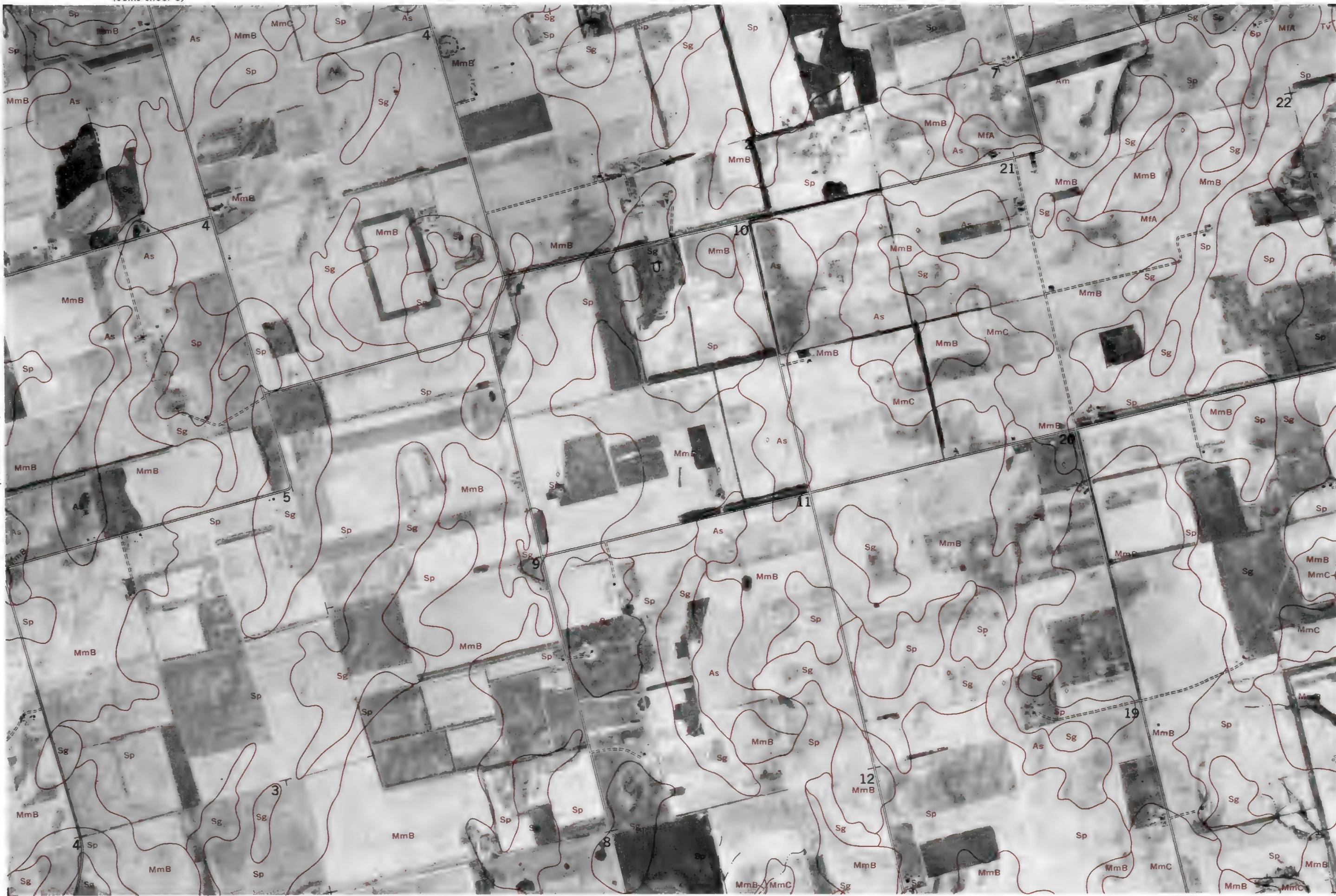
(Joins sheet 11)

WILBARGER COUNTY, TEXAS - SHEET NUMBER 8

(Joins sheet 5)

8

N



(Joins sheet 12)

0

1/2

1 Mile

0

5000 Feet

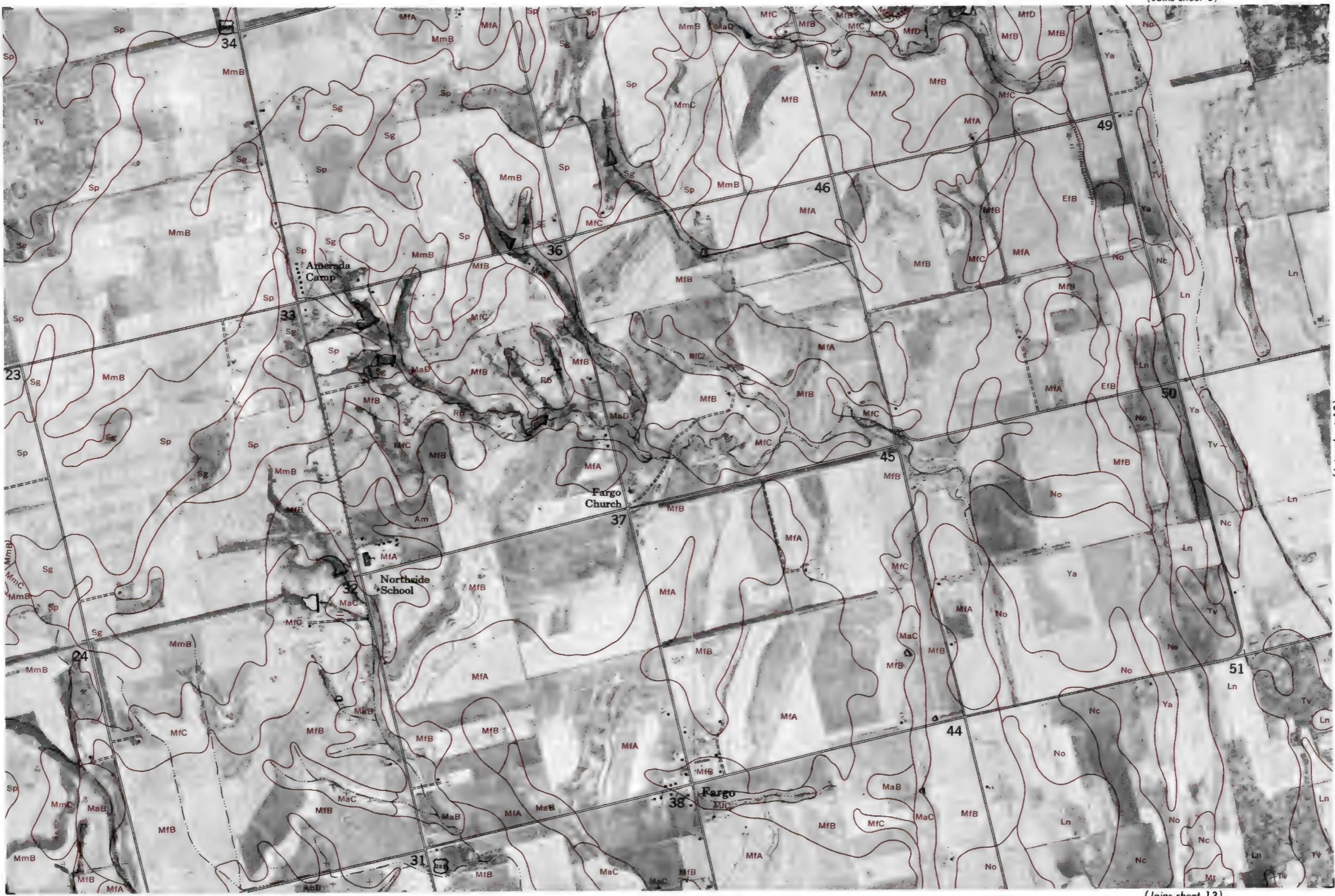
Scale 1:20 000

(Joins sheet 9)

WILBARGER COUNTY, TEXAS - SHEET NUMBER 9

(Joins sheet 6)

9



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1936.

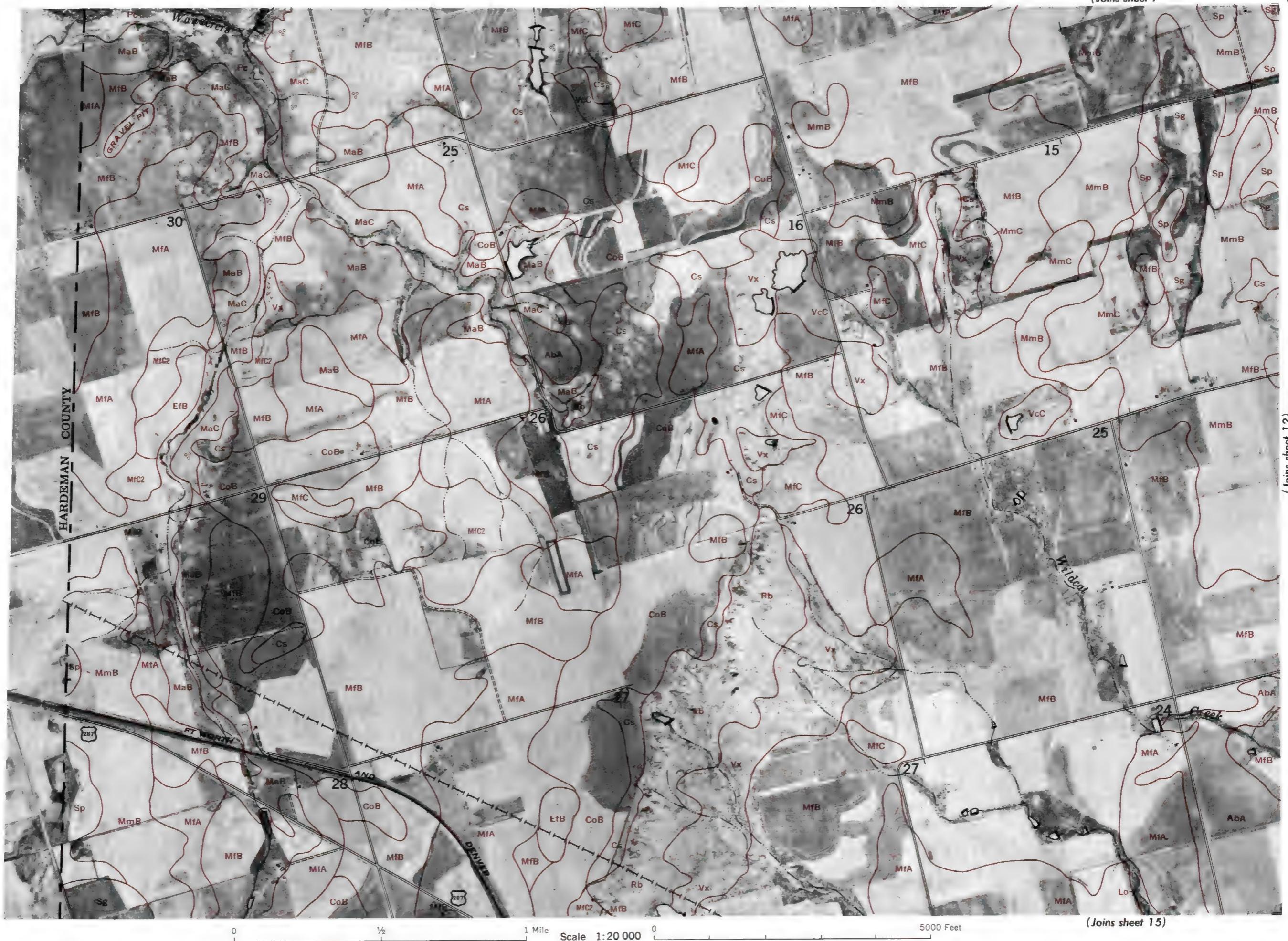
Land division corners and numbers shown on this map are indefinite.



WILBARGER COUNTY, TEXAS - SHEET NUMBER 11

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

Land division corners and numbers shown on this map are indefinite.



WILBARGER COUNTY, TEXAS - SHEET NUMBER 12

12

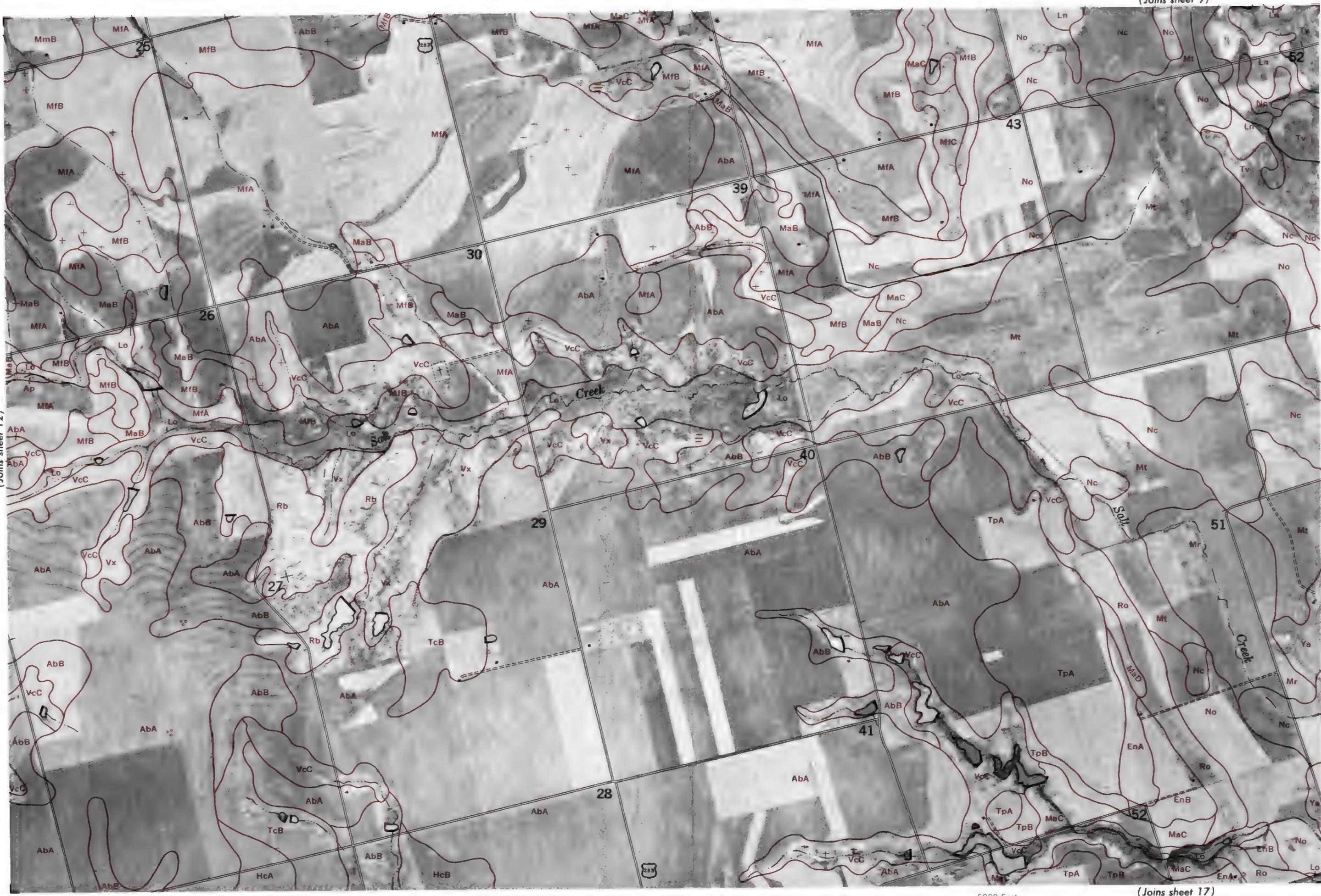
1

(Join sheet 11)

(Joins sheet 8)



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 13



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

Land division corners and numbers shown on this map are indefinite.

(Joins sheet 9)

13

N

WILBARGER COUNTY, TEXAS - SHEET NUMBER 14

14

N

(Joins sheet 13)

(Joins sheet 10)



(Joins sheet 18)

Scale 1:20 000

WILBARGER COUNTY, TEXAS - SHEET NUMBER 15

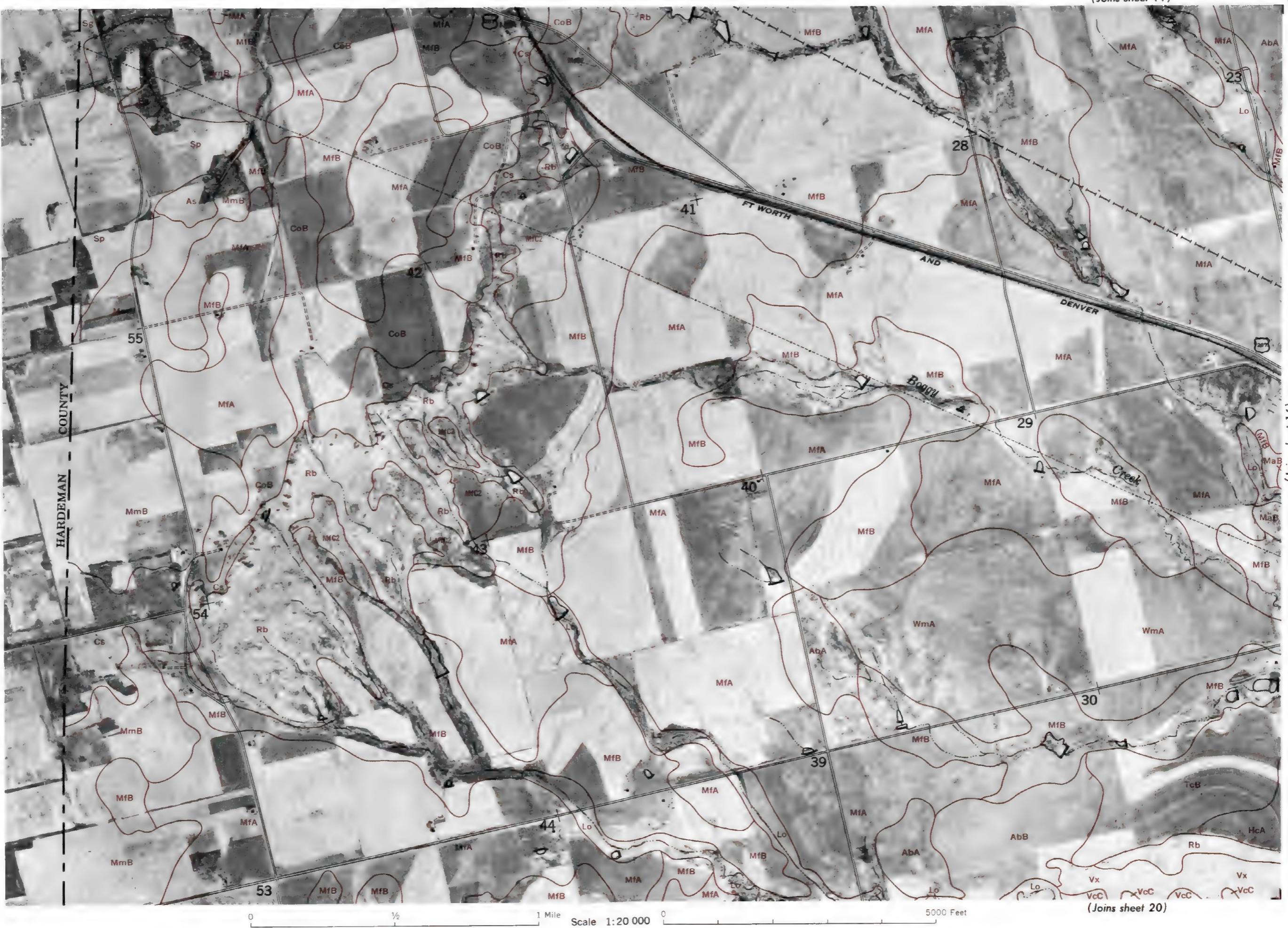
(Joins sheet 11)

15

*(Join sheet 16)*

(Joins sheet 20)

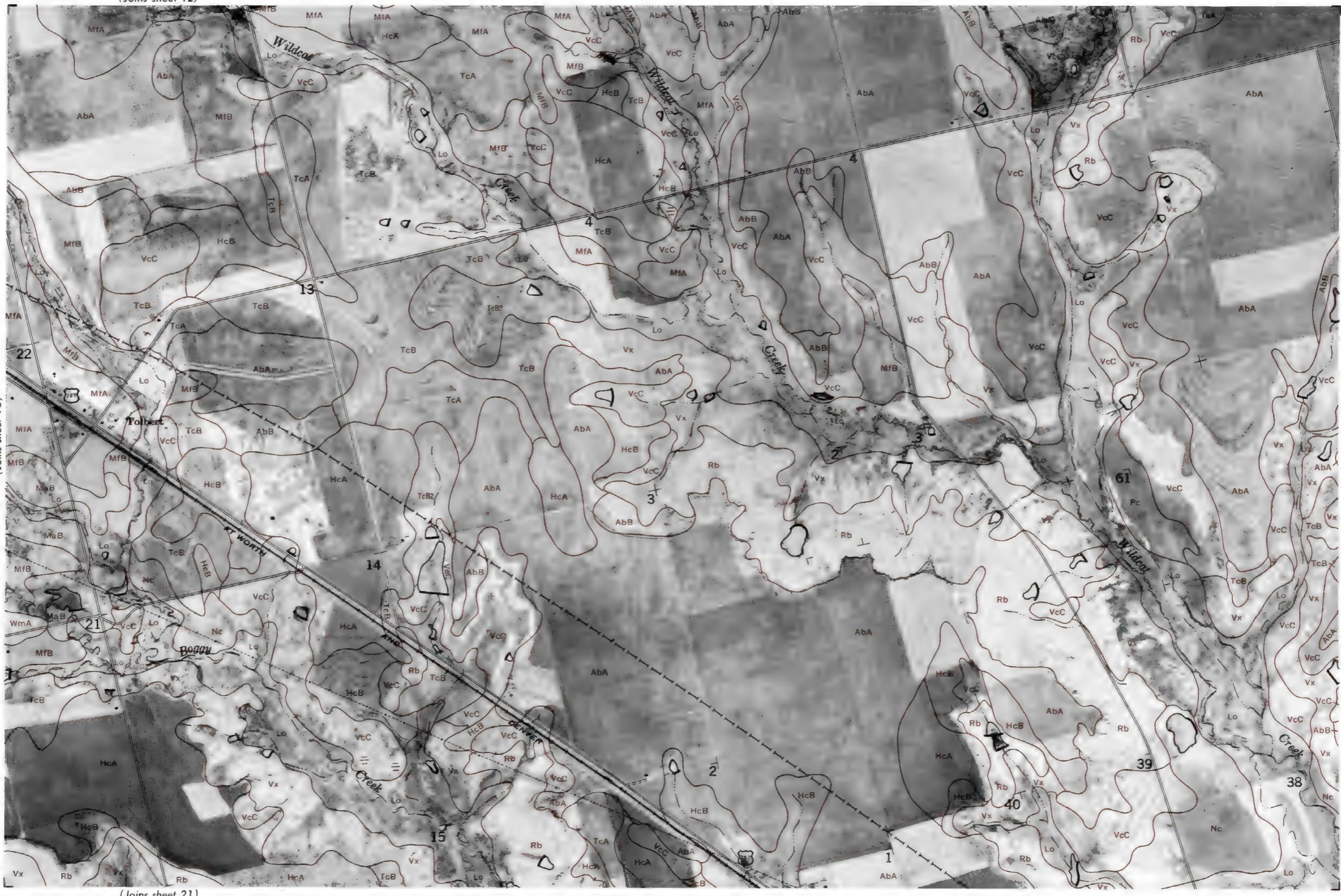
1



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 16

16

(Joins sheet 12)



(Joins sheet 21)

(Joins sheet 17)

WILBARGER COUNTY, TEXAS - SHEET NUMBER 17



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

Land division corners and numbers shown on this map are indefinite.

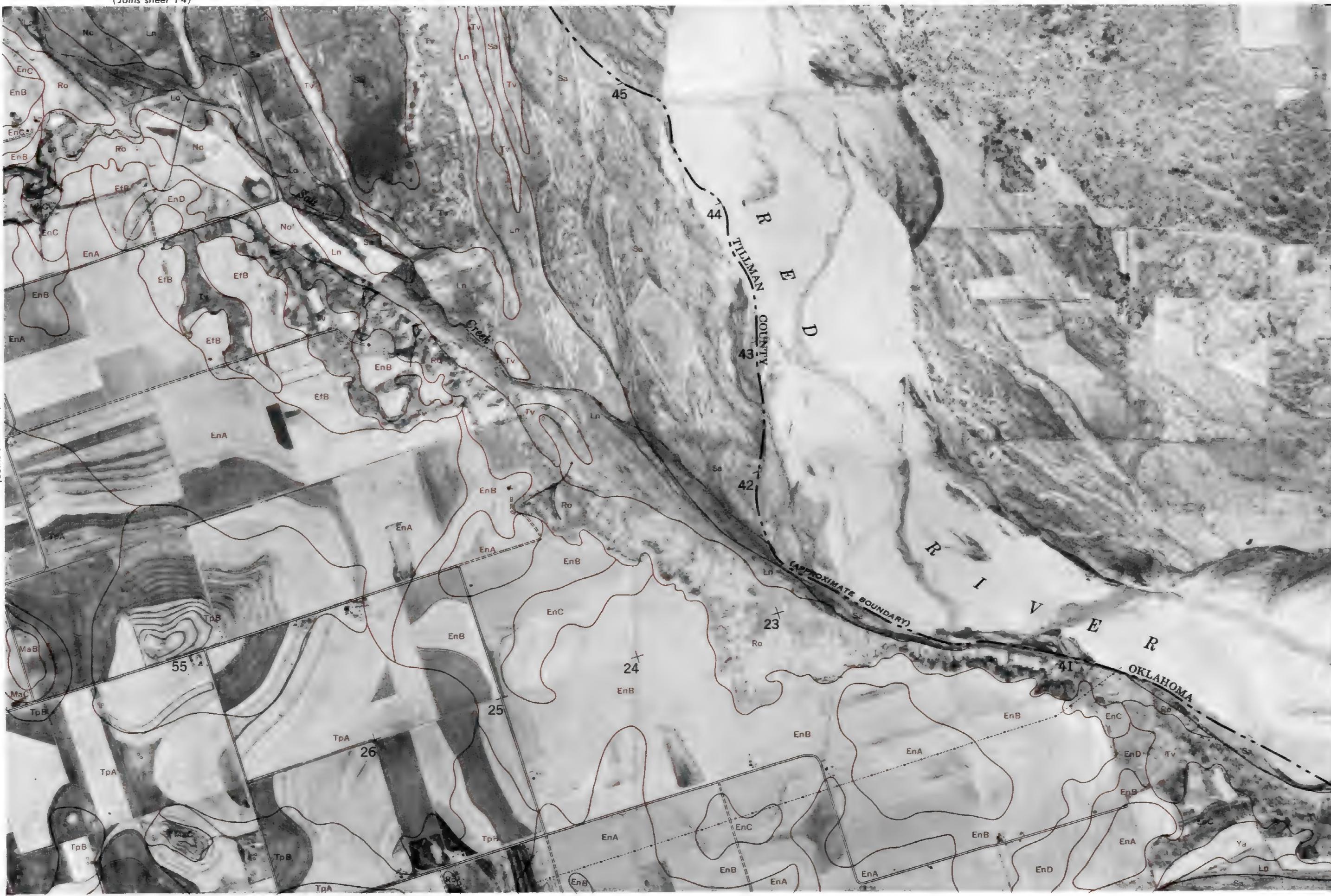
WILBARGER COUNTY, TEXAS - SHEET NUMBER 18

18

N

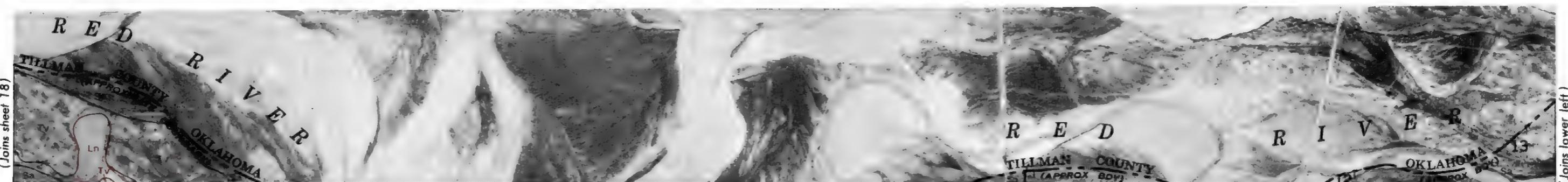
(Joins sheet 17)

(Joins sheet 14)



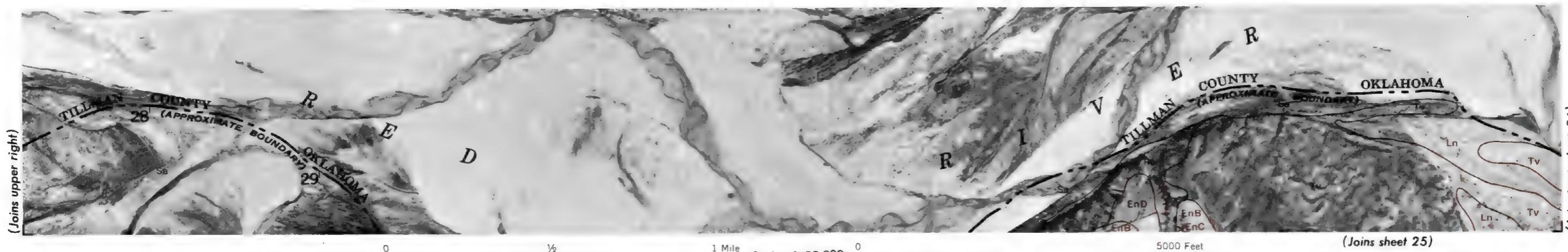
WILBARGER COUNTY, TEXAS - SHEET NUMBER 19

(19)



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

Land division corners and numbers shown on this map are indefinite.



(Joins sheet 18)

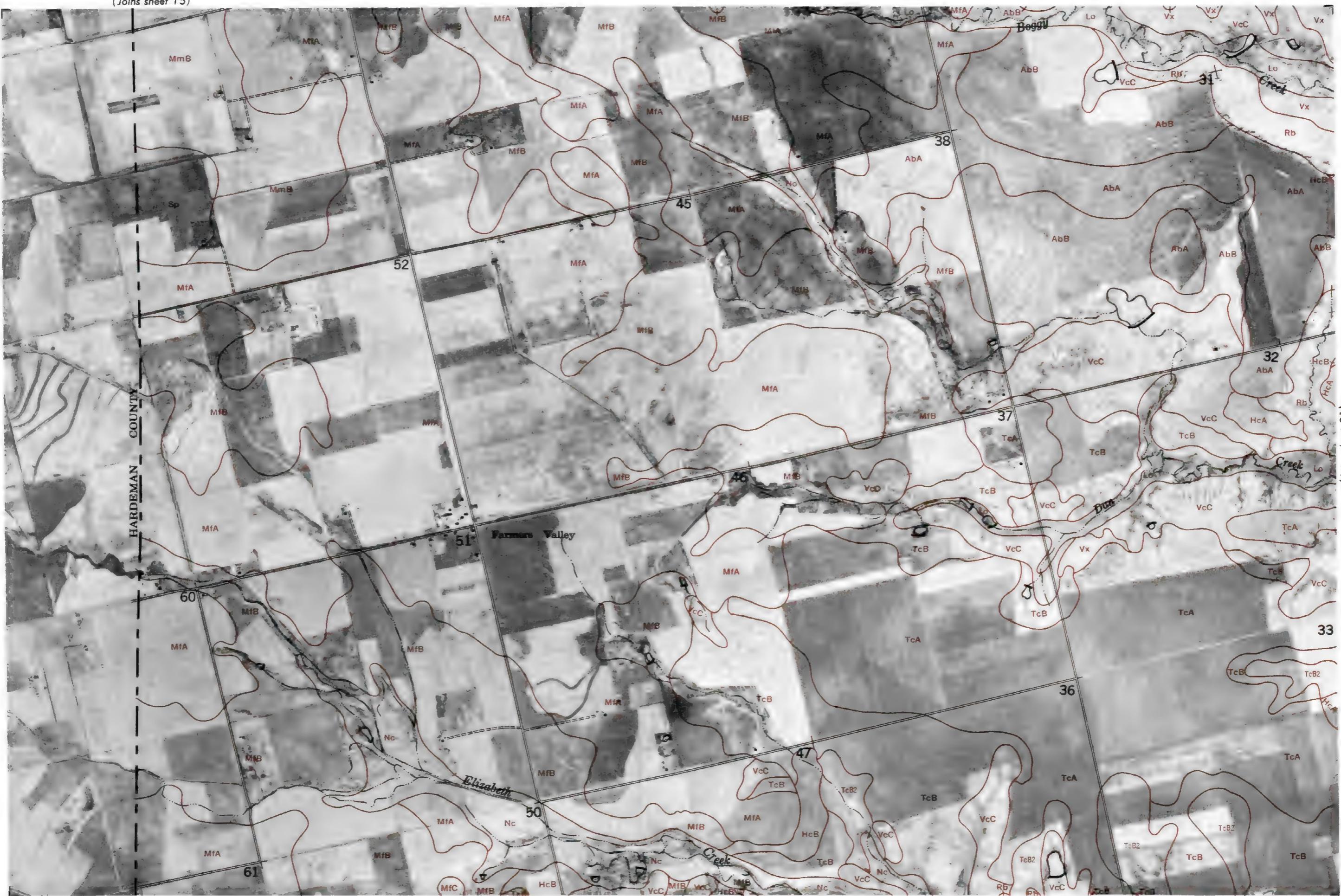
(Joins inset, sheet 25)

WILBARGER COUNTY, TEXAS - SHEET NUMBER 20

(20)

N

(Joins sheet 15)



(Joins sheet 21)

(Joins sheet 27)

0

1/2

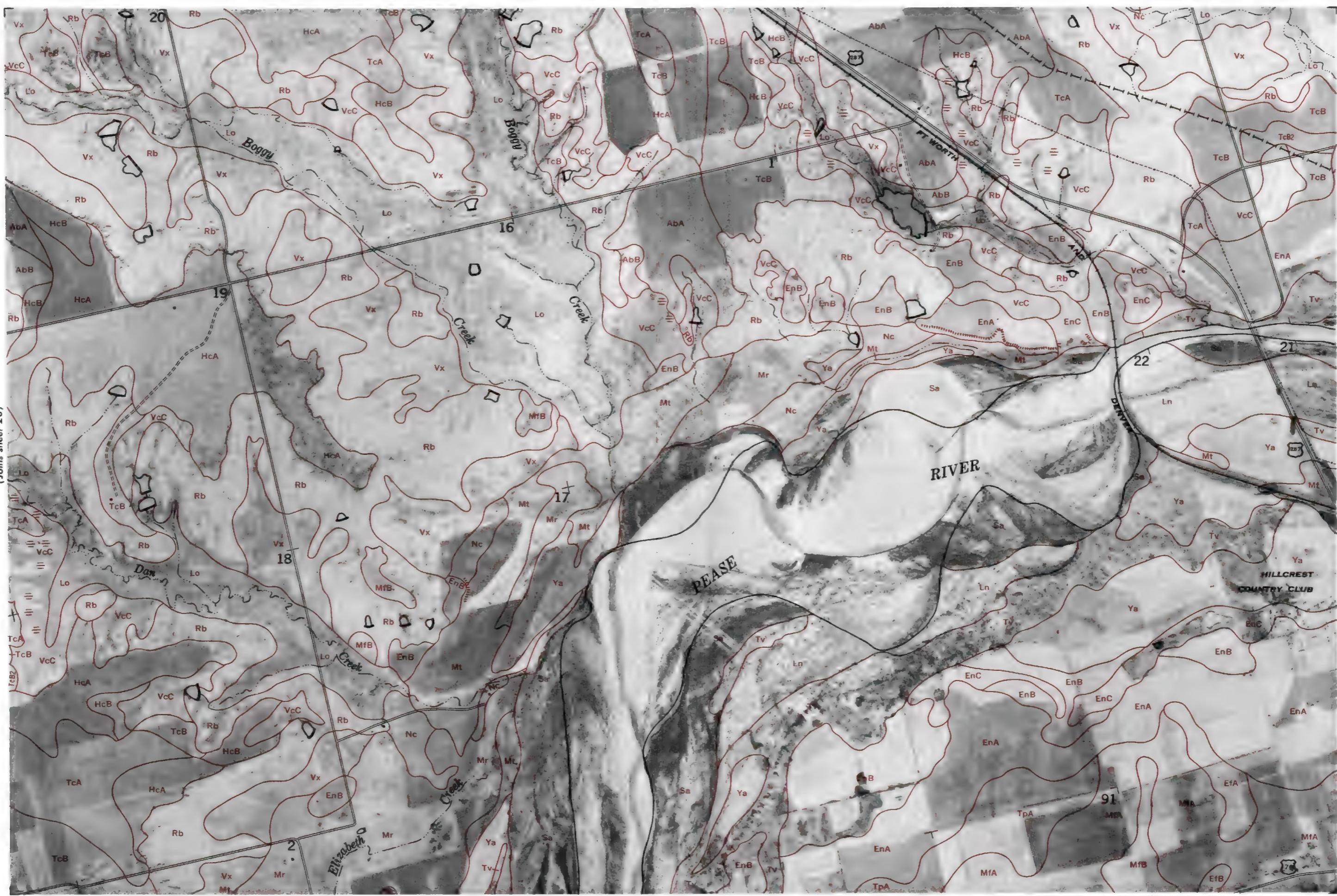
Scale 1:20 000

0  
5000 Feet

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 21

(Joins sheet 16)

21



22

N

(Joins sheet 17)

This figure is a detailed topographic map of a mountainous region. The map features several contour lines indicating elevation changes. A prominent feature is a large, dark shaded area representing a reservoir or lake, labeled 'Sa' (likely Saguache Reservoir). Several rivers and streams are shown flowing through the terrain, with one major river labeled 'RIVER' and another labeled 'Creek'. A winding road follows the course of the River. The map is covered with numerous labels identifying specific locations and geological features. Some labels include: AbB, AbA, VcD, MaB, Vx, Lo, TpB, MaC, Rb, EnB, End, EnD, EnB, EnA, Ro, Mt, Ya, Sa, RIVER, Creek, 70, 28, 14, 13, and Paradise. Contour lines are numbered with values such as 31, 30, and 14. A scale bar at the bottom left indicates distances up to 1 mile.

(Joins sheet 29)

1

8

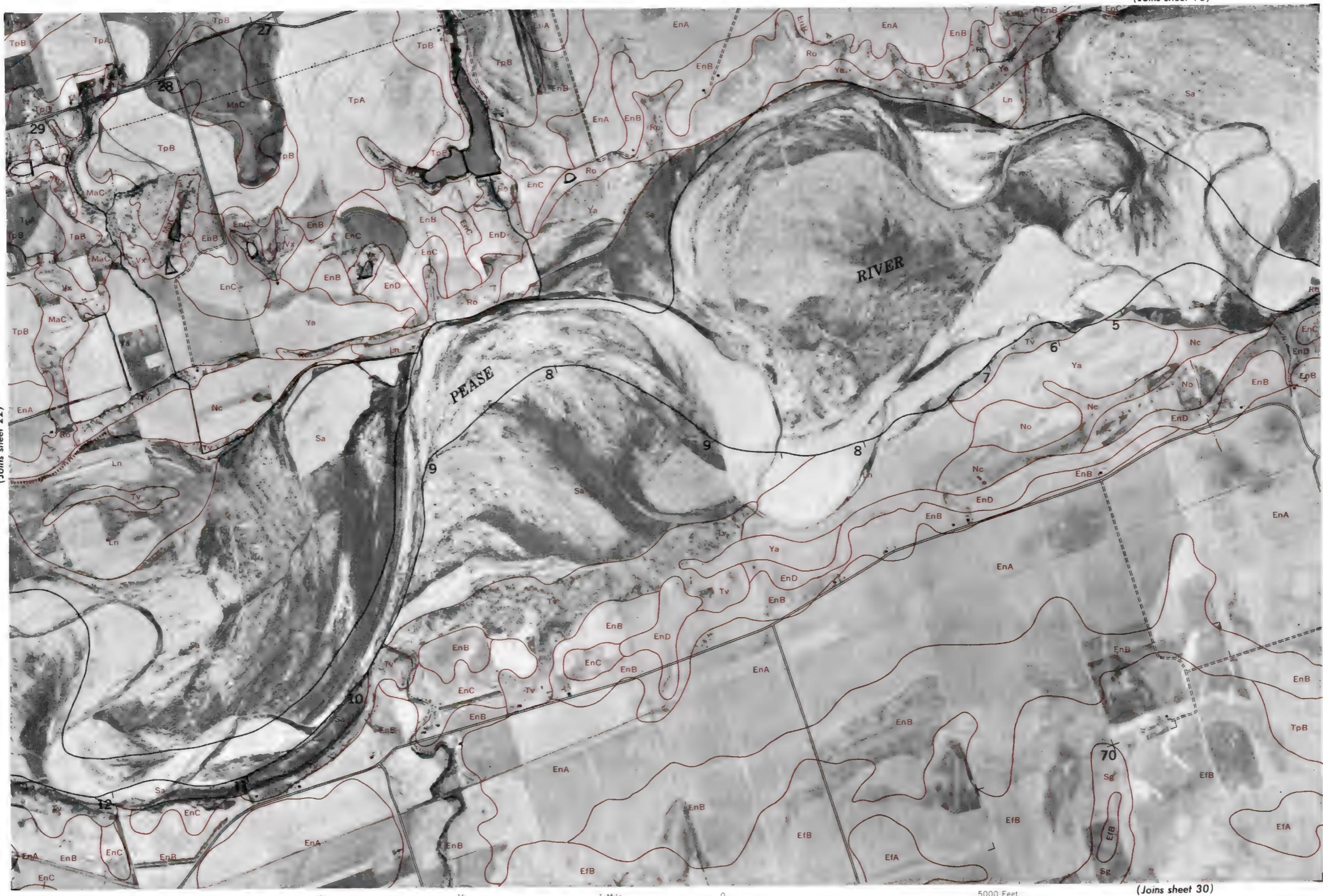
net

(Join sheet 23)

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 23

(Joins sheet 18)

23



(Joins sheet 24)

23

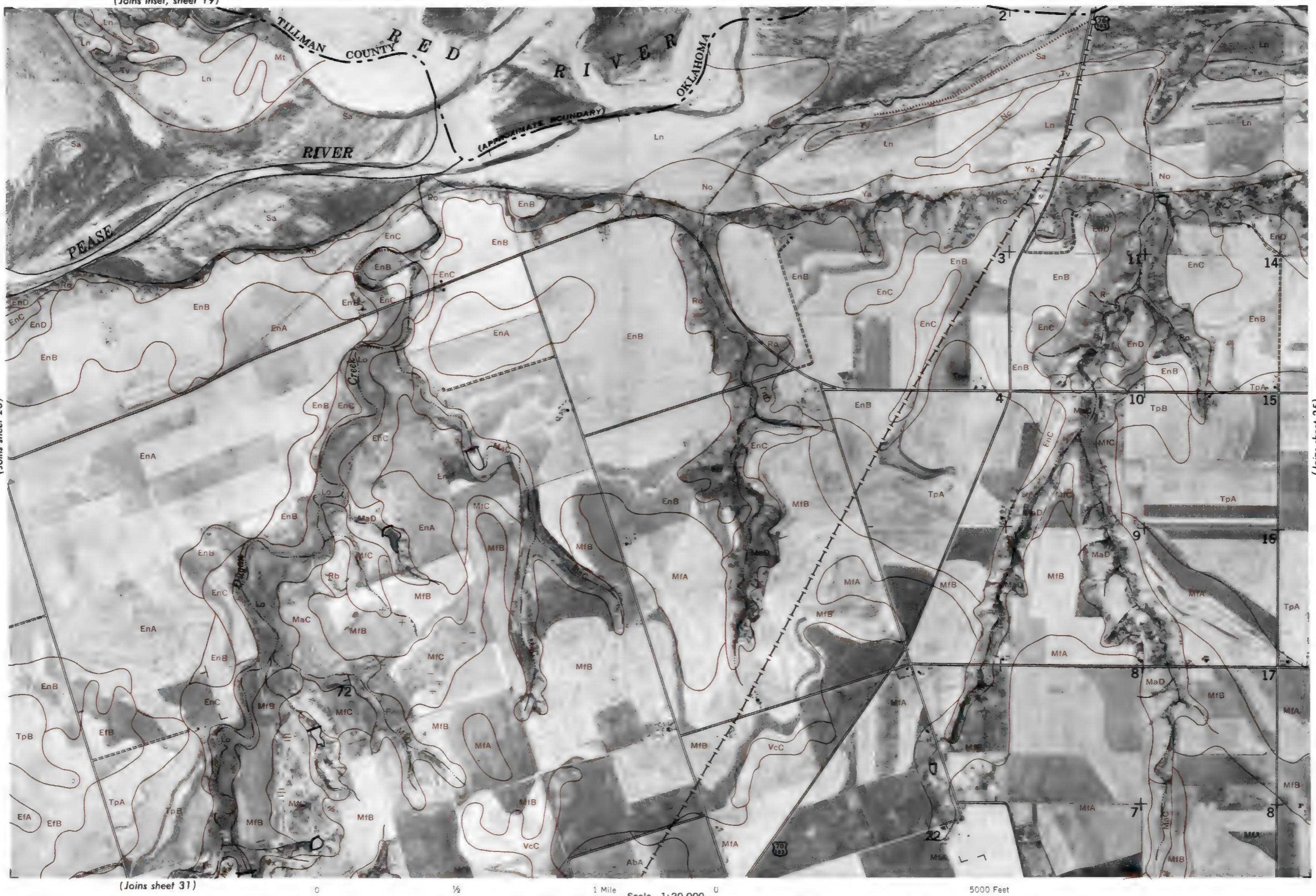
(Joins inset, sheet 19)

24

N

(Joins sheet 23)

(Joins sheet 25)



WILBARGER COUNTY, TEXAS - SHEET NUMBER 25

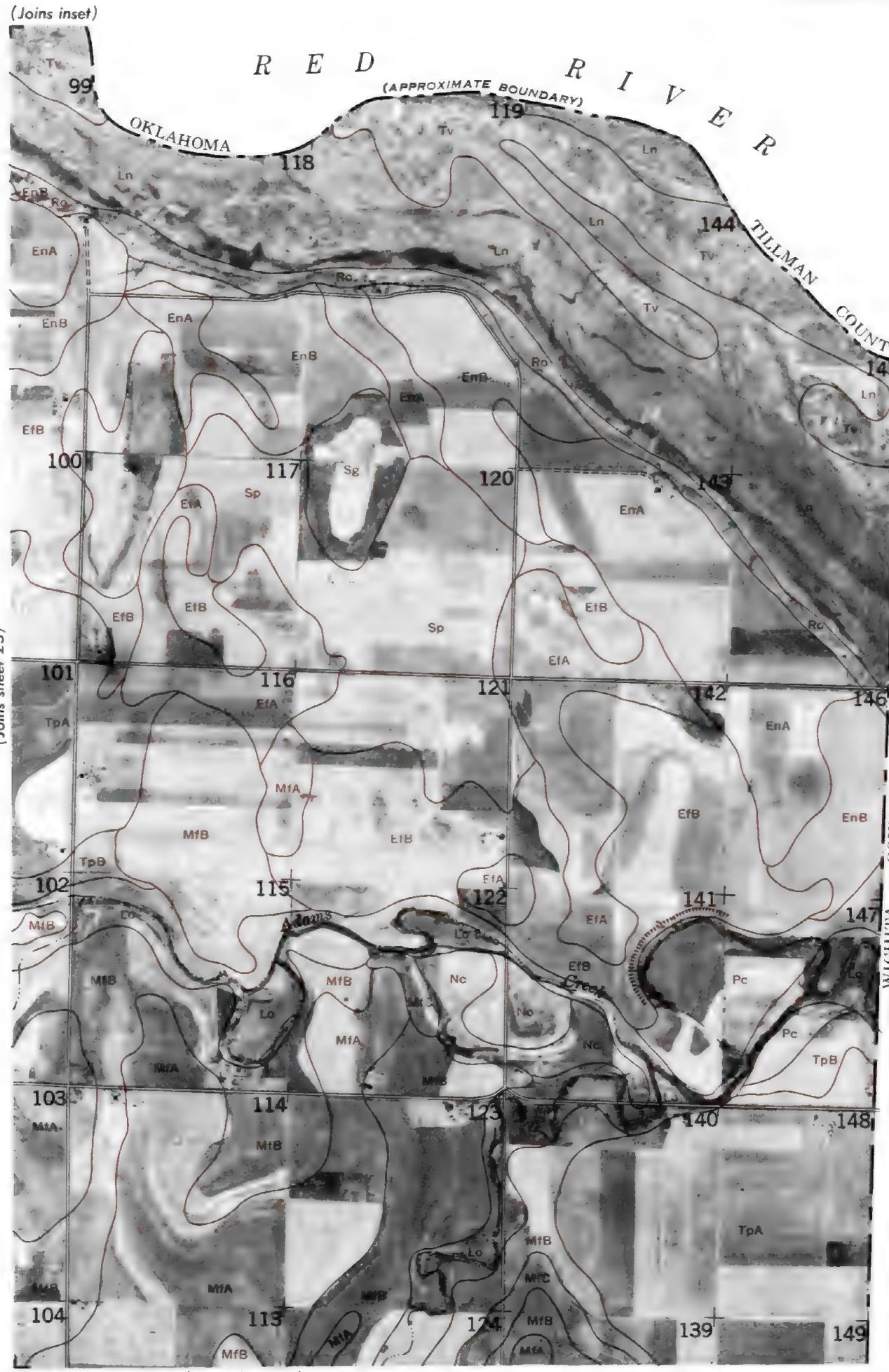
(Joins sheet 19)

25



WILBARGER COUNTY, TEXAS - SHEET NUMBER 26

(26)



WILBARGER COUNTY, TEXAS - SHEET NUMBER 27

(Joins sheet 20)

27

(Joins sheet 28)

In case of any question regarding the acreage or survey report, write the State Conservation Service, U.S. Fish and Game Commission, Agassiz, Wash., or the State Surveyor General, Olympia, Wash.

Land division corners and numbers shown on this map are indefinite



WILBARGER COUNTY, TEXAS - SHEET NUMBER 28

(28)

N  
↑



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 29

(Joins sheet 22)

29



WILBARGER COUNTY, TEXAS - SHEET NUMBER 30

(30)

N

(Joins sheet 23)



(Joins sheet 29)

(Joins sheet 31)

(Joins sheet 37)

0

½

1 Mile

Scale 1:20 000

0

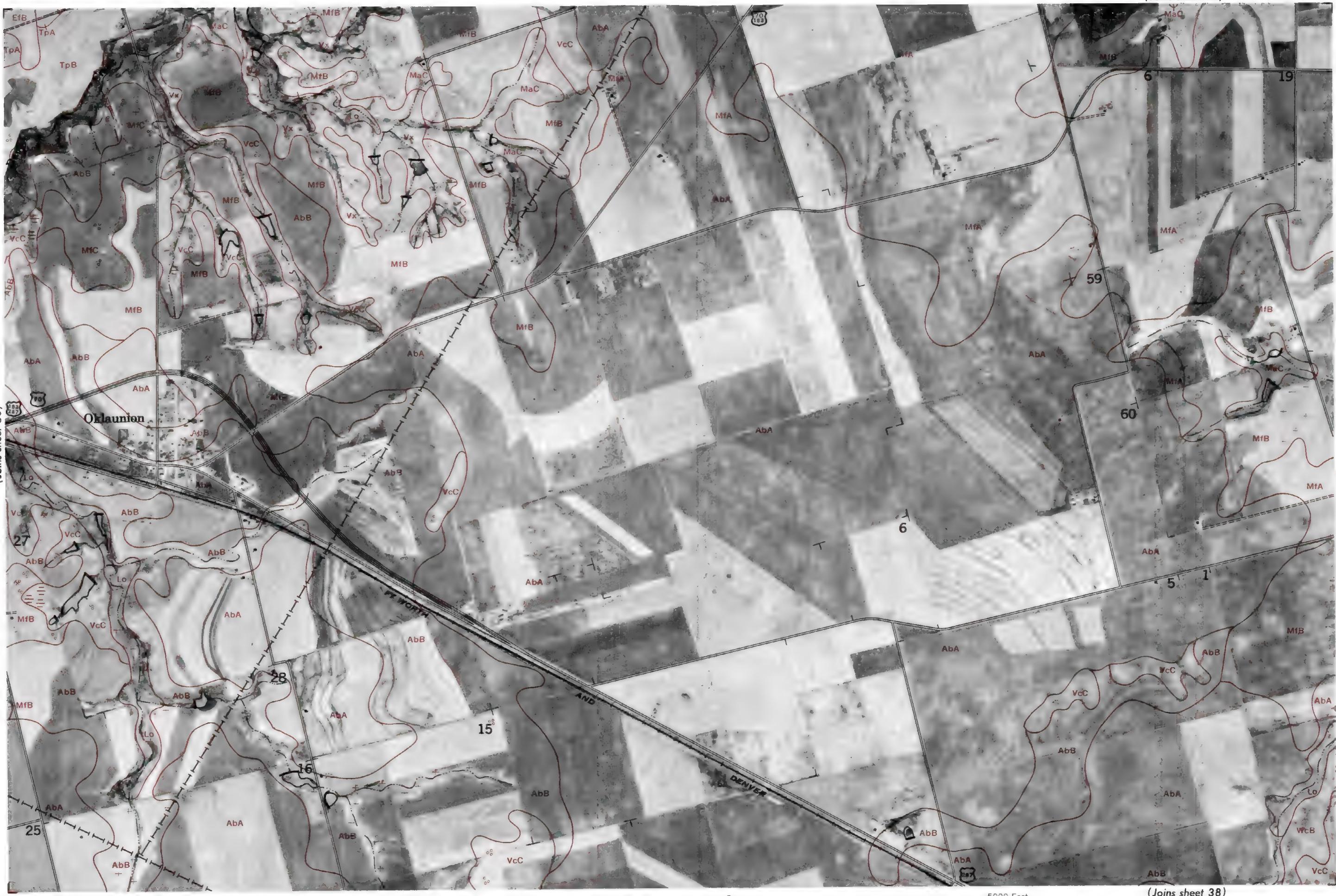
5000 Feet

WILBARGER COUNTY, TEXAS - SHEET NUMBER 31

(Joins sheet 24)

31

N  
↑



(Joins sheet 32)

31

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 32

32

(Joins sheet 25)

N  
↑

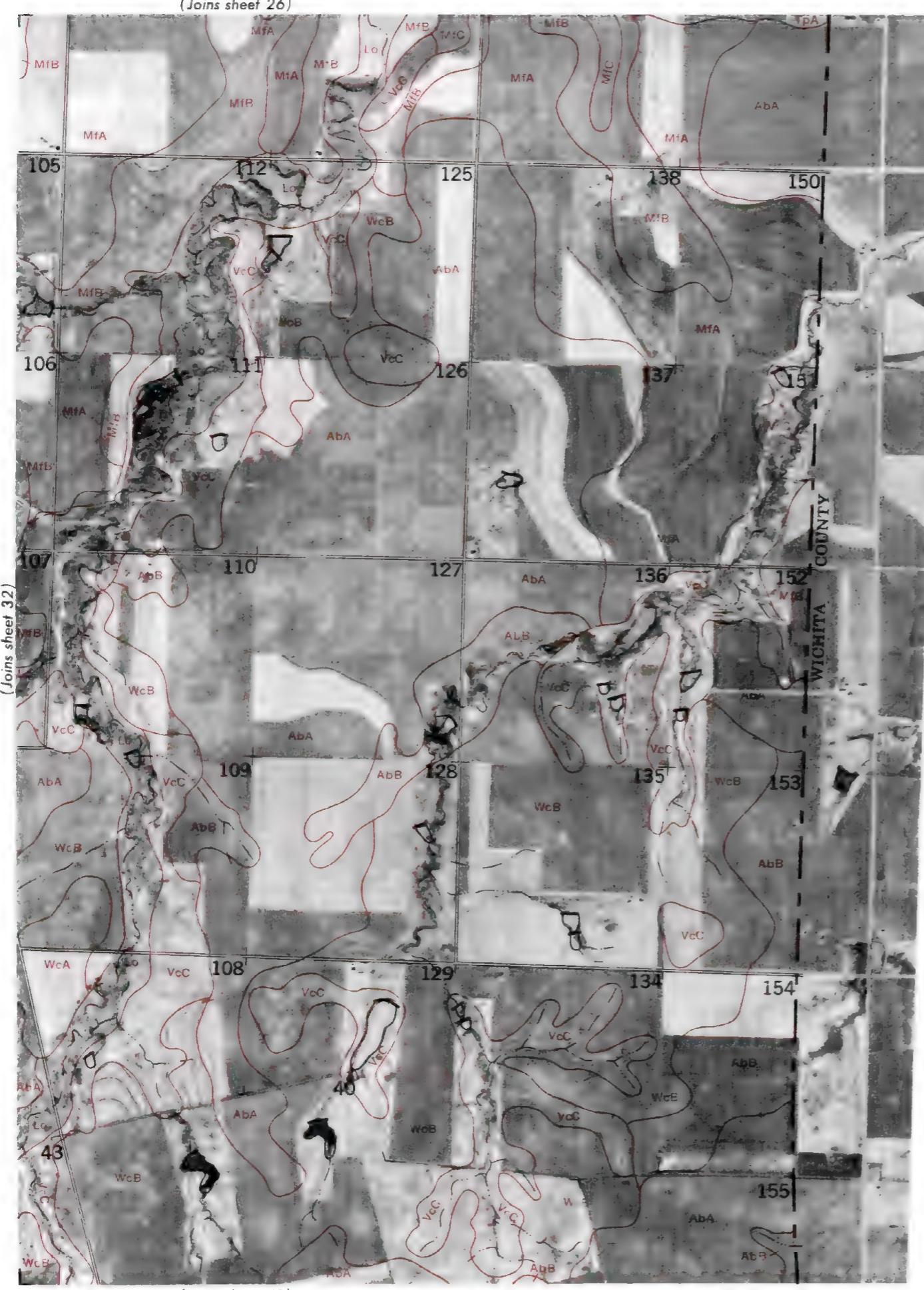
(Joins sheet 31)

(Joins sheet 33)

(Joins sheet 39)

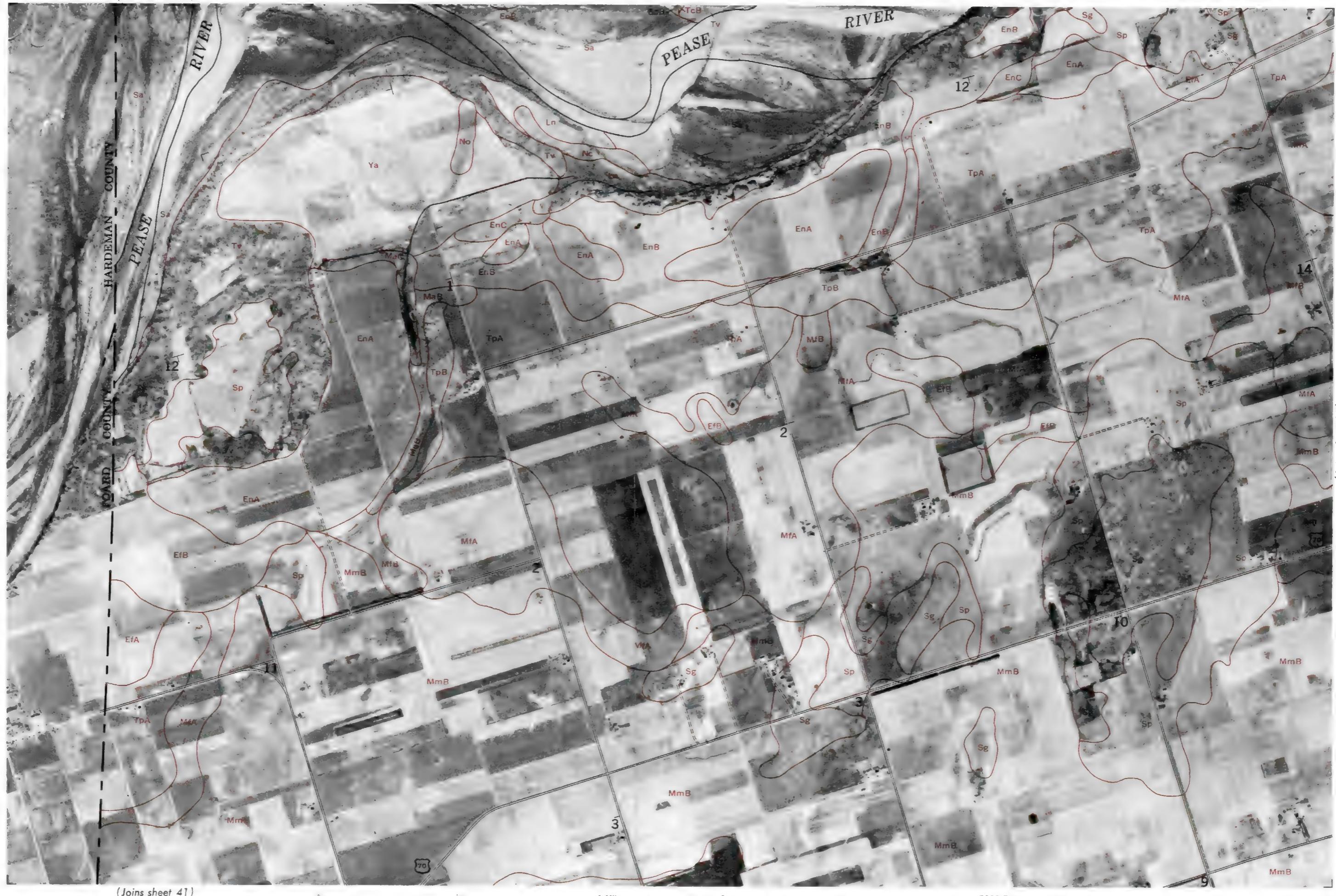
Scale 1:20 000

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 33



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs taken in 1956.

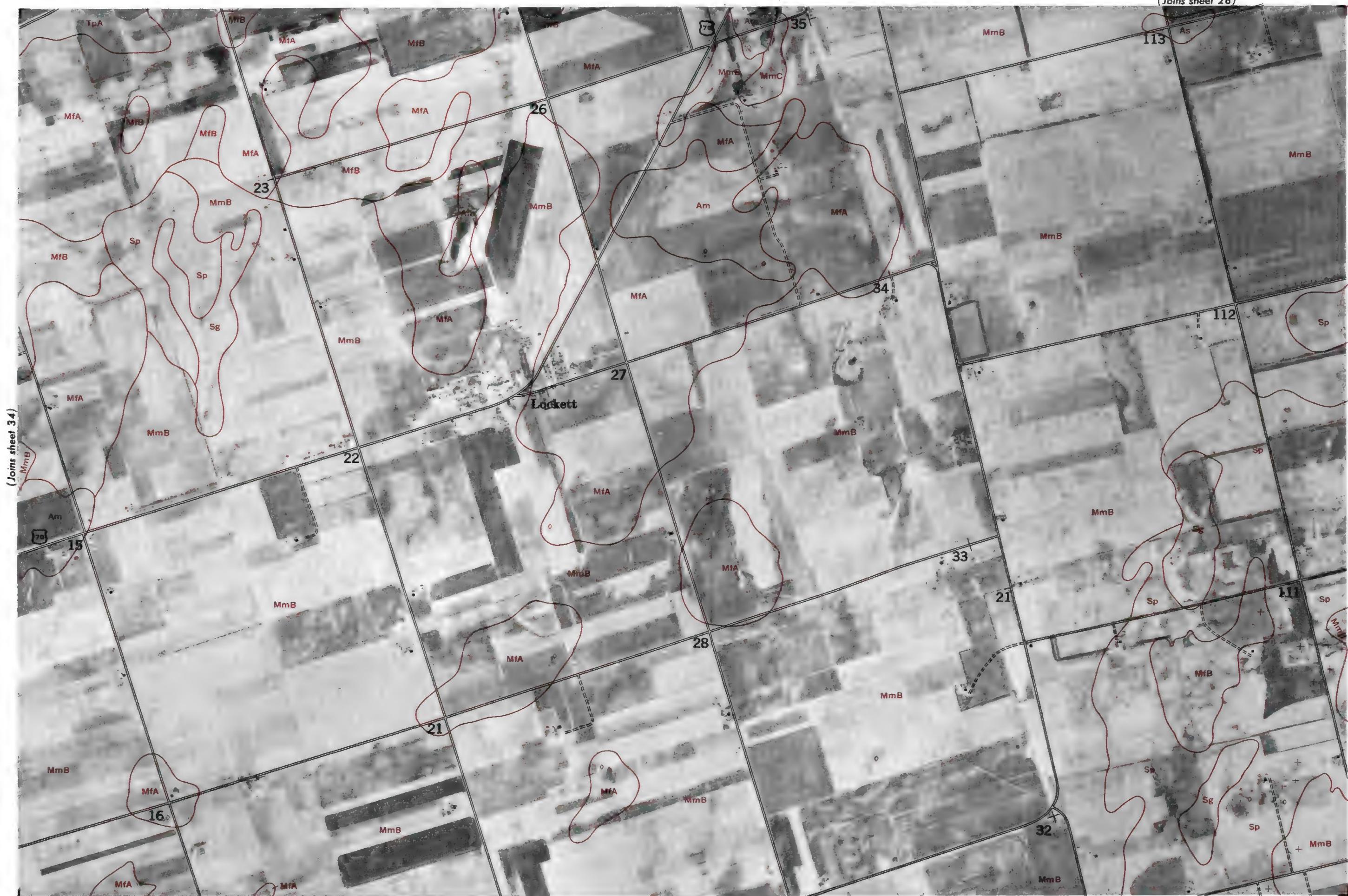
Land division corners and numbers shown on this map are indefinite.



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 35

(Joins sheet 28)

35



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 36

36

(Joins sheet 29)



(Joins sheet 35)

(Joins sheet 37)

(Joins sheet 43)

Scale 1:20 000

5000 Feet





WILBARGER COUNTY, TEXAS - SHEET NUMBER 3

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

Land division corners and numbers shown on this map are indefinite.

Linea 28

Hains sheet 38

(Joins sheet 38)

(Joins sheet 38)

(Join sheet 38)

(Join sheet 38)

卷之三

卷之三

W

Wc

WcE

WcB

2  
V  
cB

27  
Vol.  
cB

27

27 v

W  
fcC

H w  
cc

W.C. 1900

Wc

WCE

4cB

c8

• 8

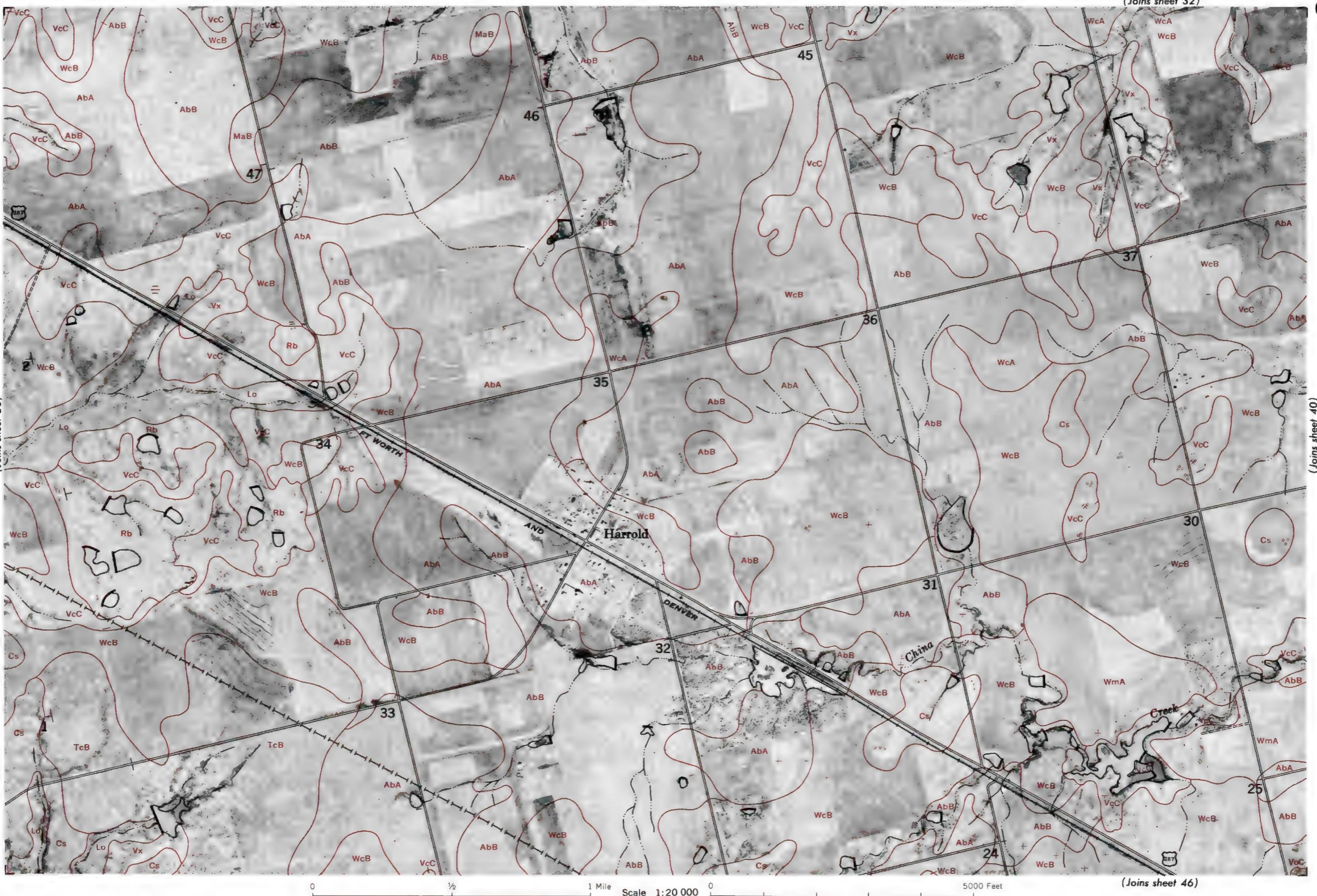
卷之三

Locality H.

Join sheet 38)

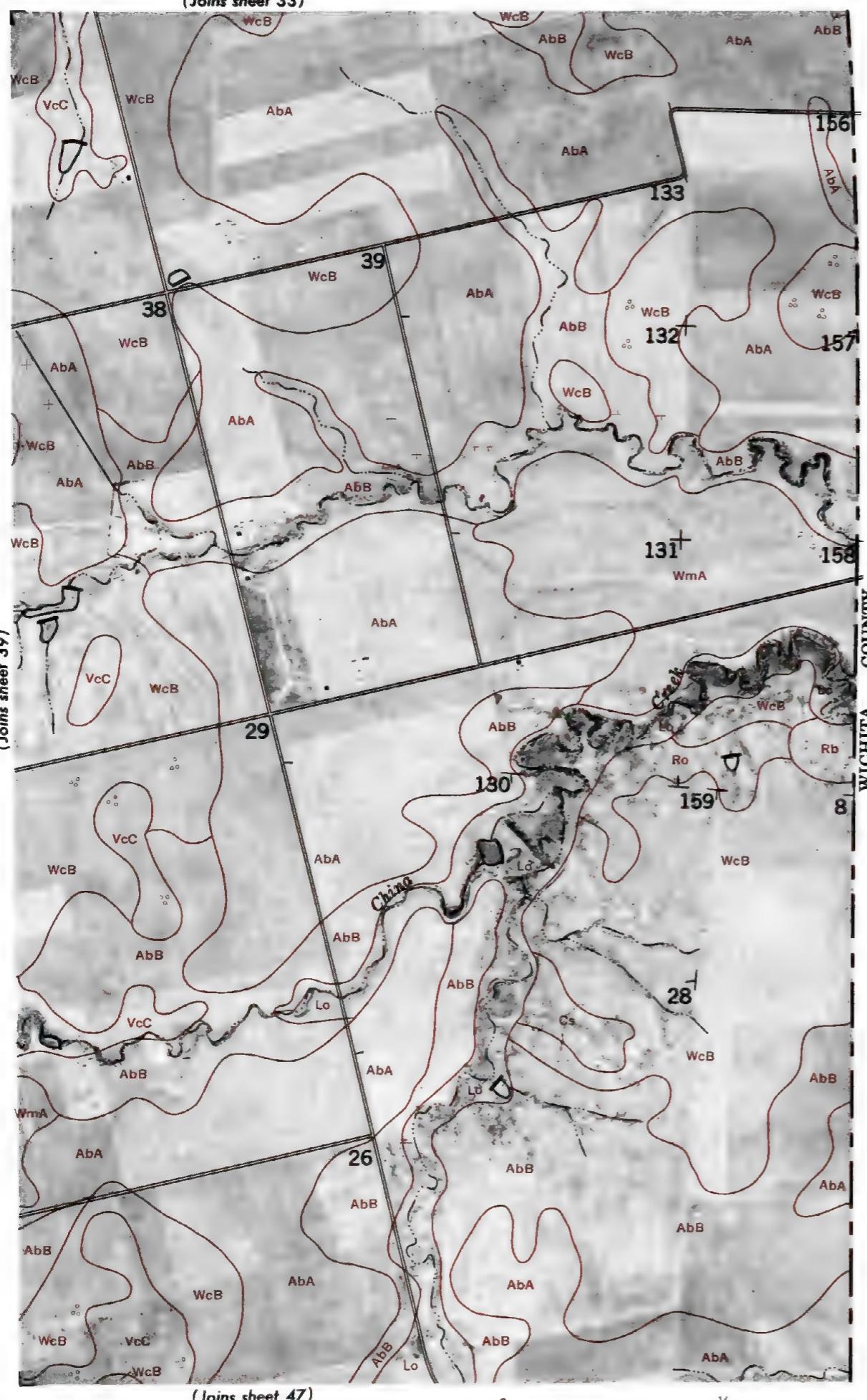
Join sheet 32)

39



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 40

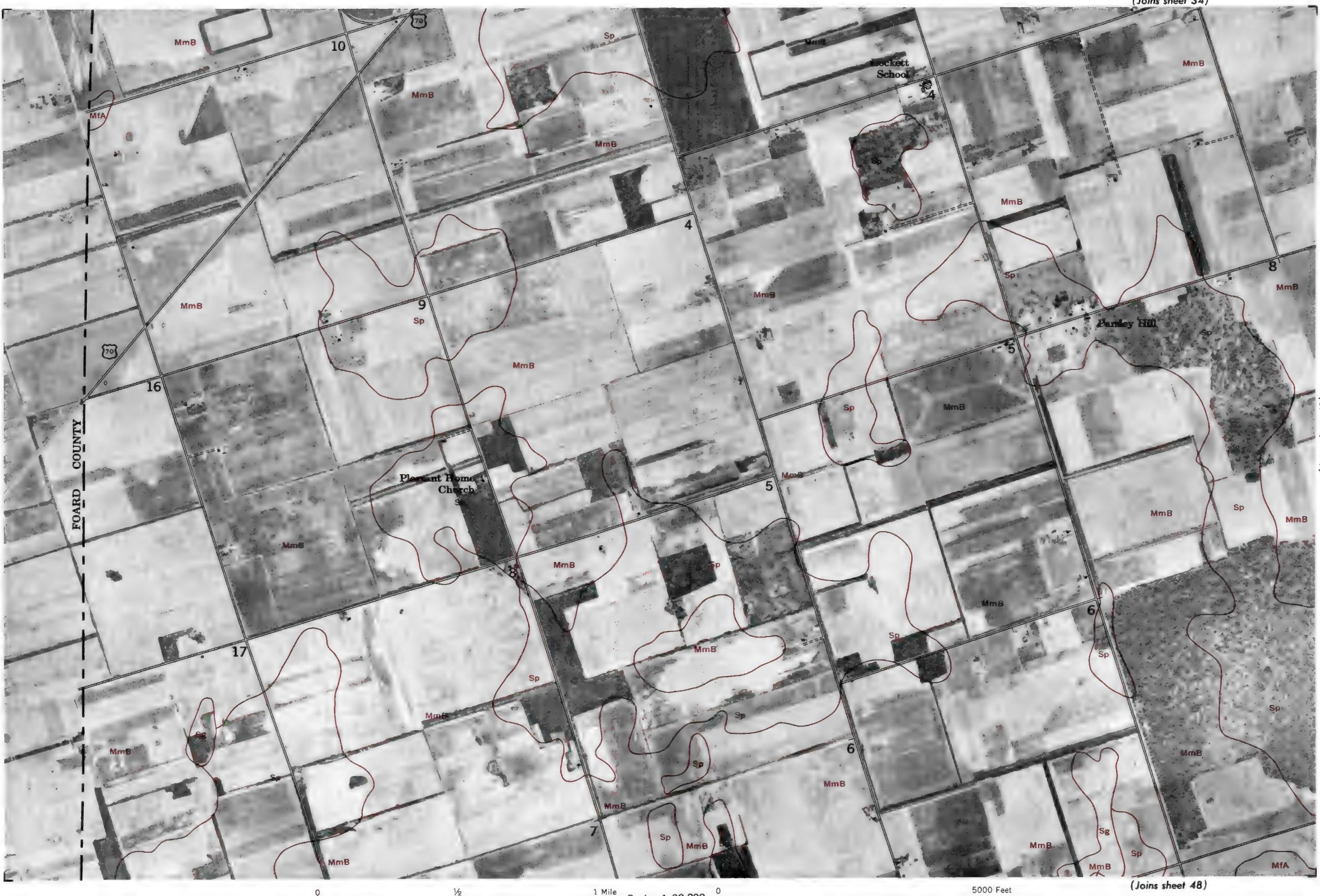
40

N  
↑

WILBARGER COUNTY, TEXAS - SHEET NUMBER 41

This is one or a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report on the information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

Land division corners and numbers shown on this map are indefinite.



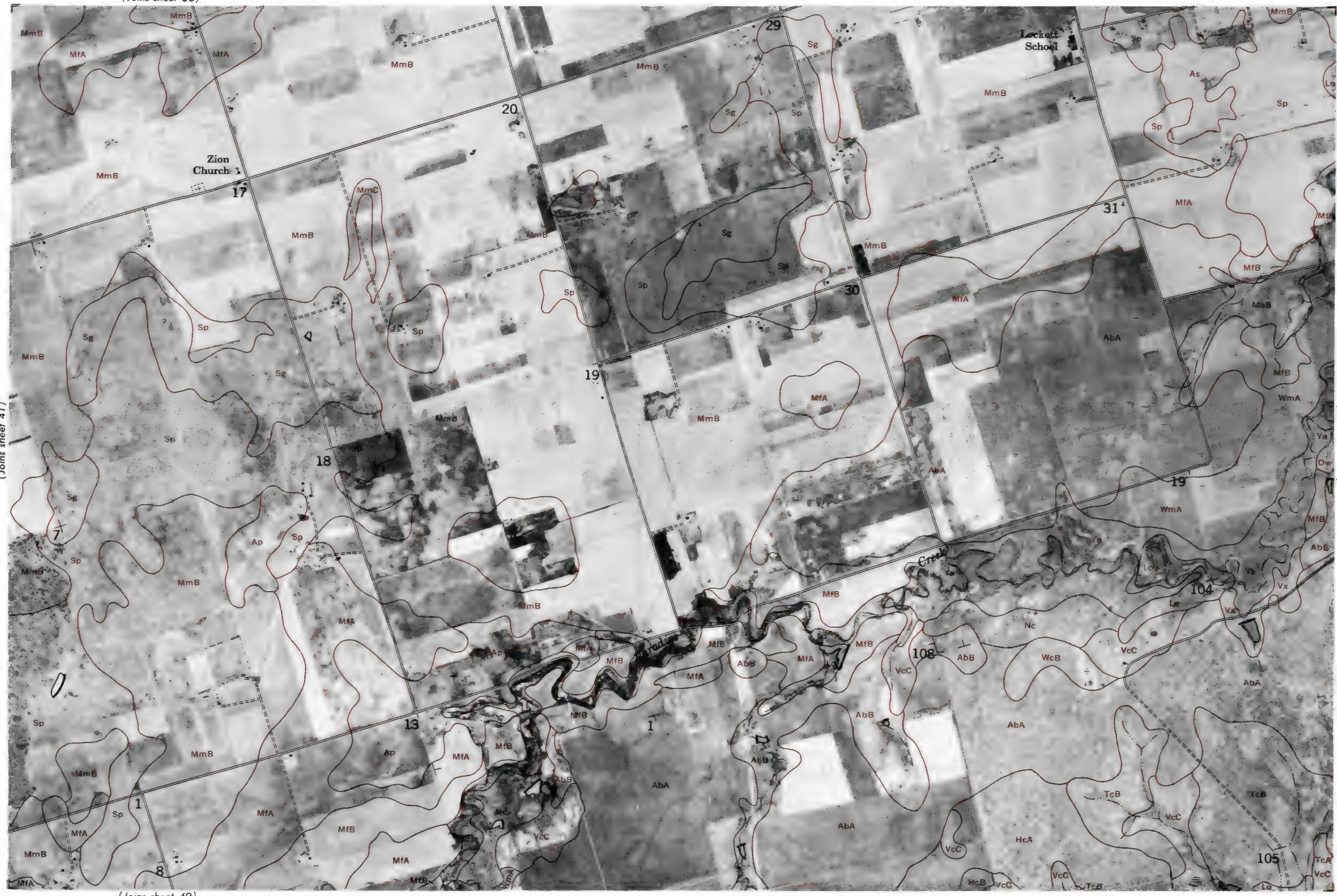
WILBARGER COUNTY, TEXAS - SHEET NUMBER 42

42

N

(Joins sheet 41)

(Joins sheet 35)



(Joins sheet 43)

Scale 1:20 000

WILBARGER COUNTY, TEXAS - SHEET NUMBER 43

(Joins sheet 36)

43

Land division corners and numbers shown on this map are indefinite.

(Joins sheet 42)

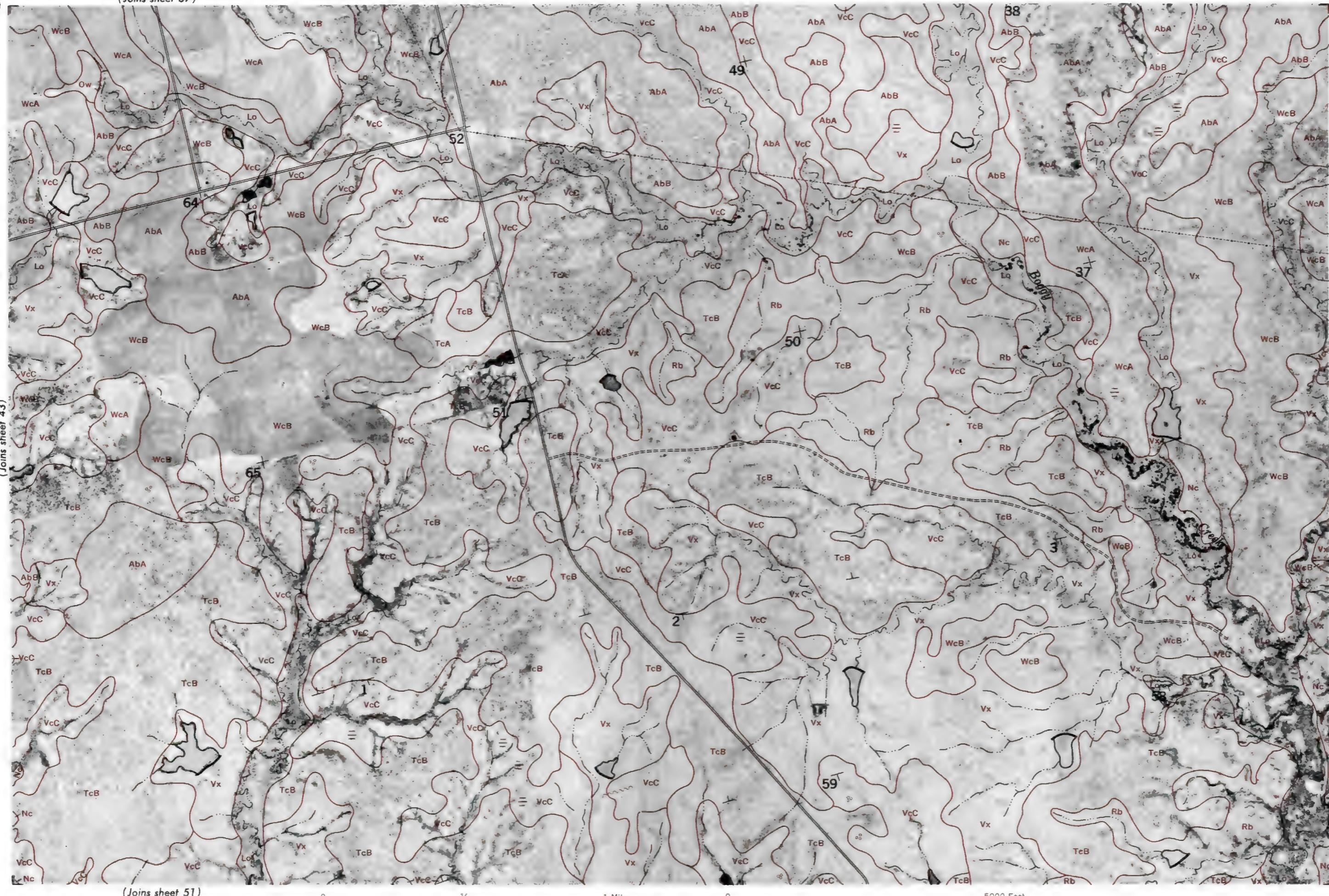


## WILBARGER COUNTY, TEXAS - SHEET NUMBER 44

44

N  
↑

(Joins sheet 37)

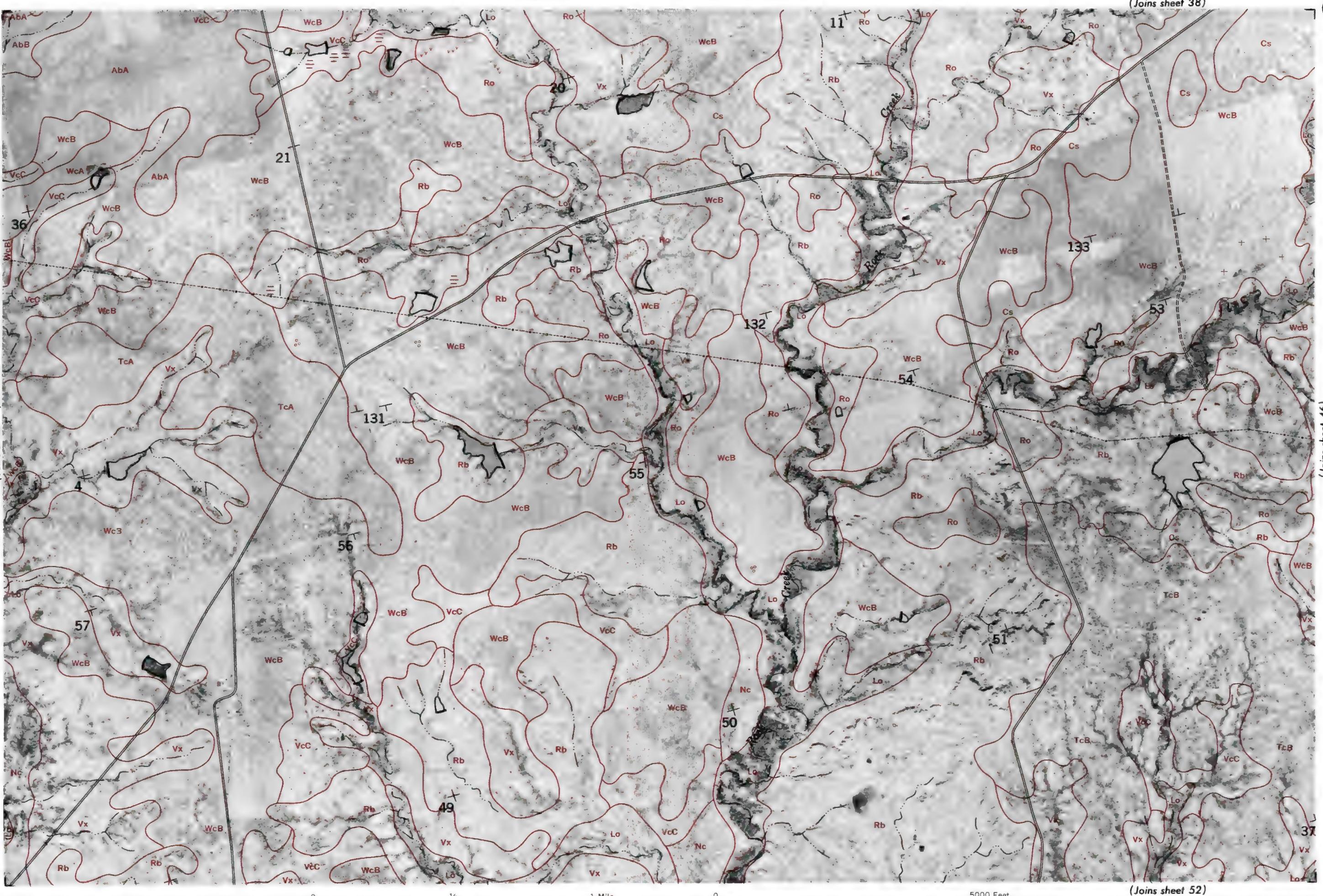


(Joins sheet 43)

(Joins sheet 45)

(Joins sheet 51)

WILBARGER COUNTY, TEXAS - SHEET NUMBER 45



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from serial photographs flown in 1956.

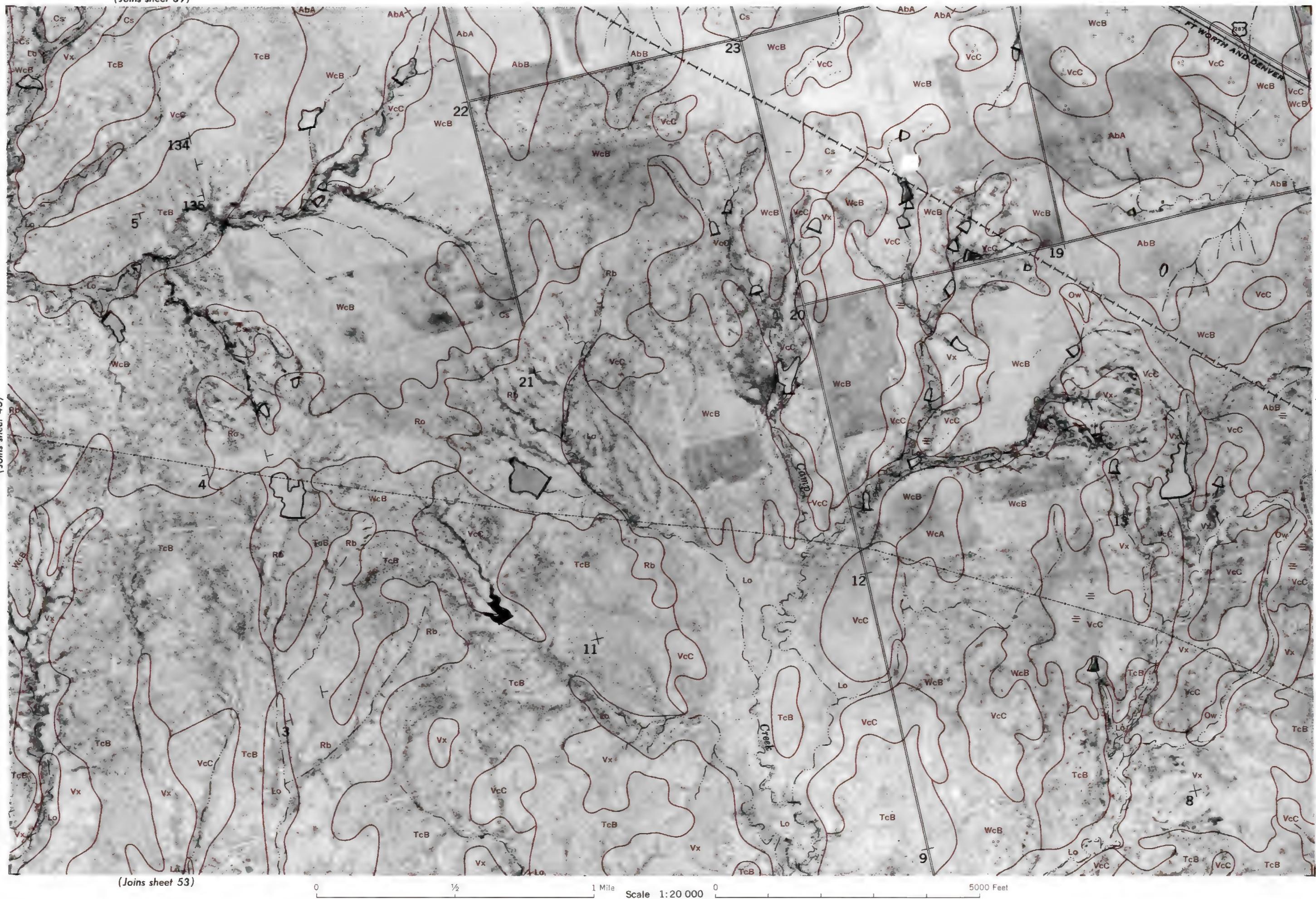
Land division corners and numbers shown on this map are indefinite.

WILBARGER COUNTY, TEXAS - SHEET NUMBER 46

(Joins sheet 39)

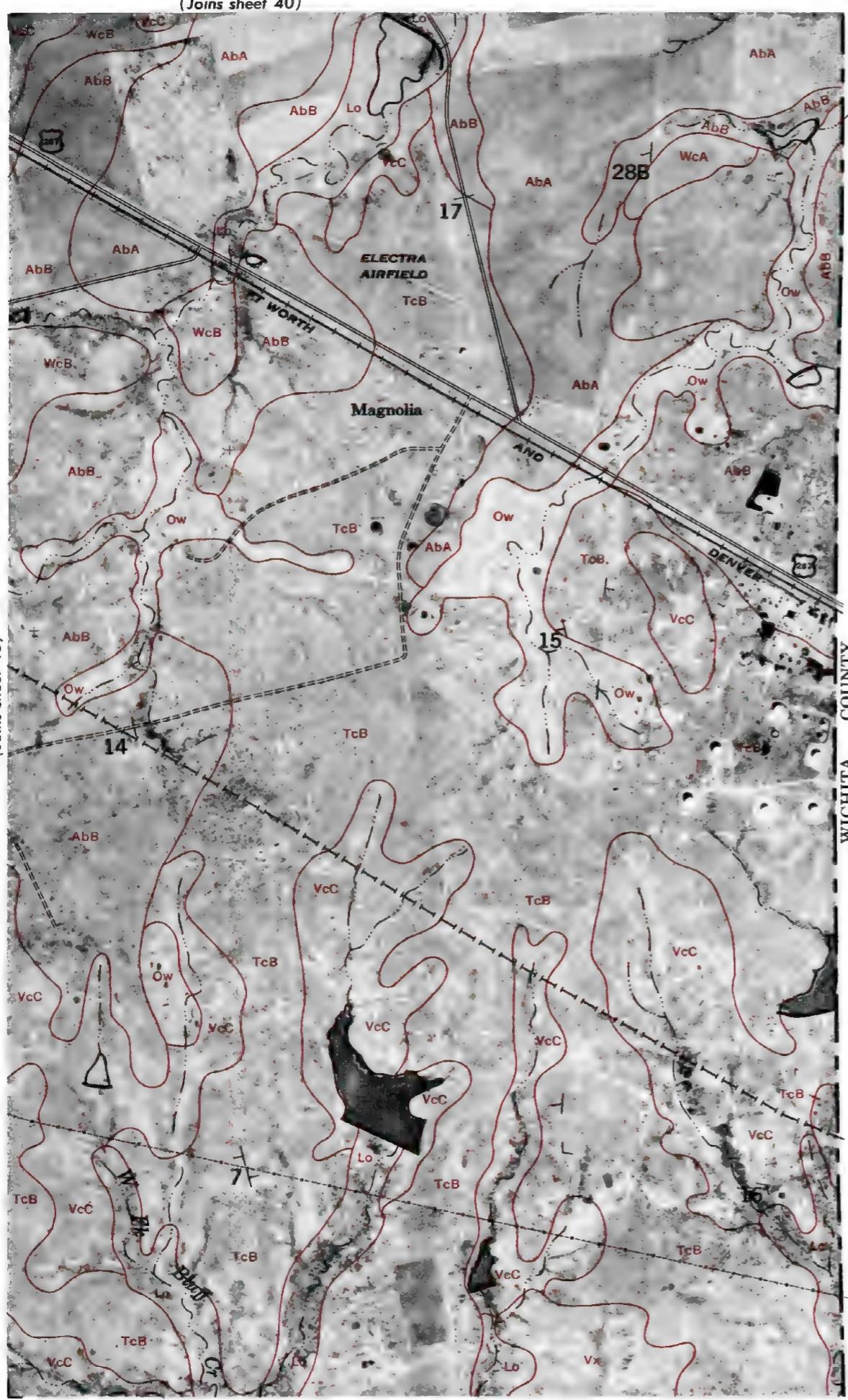
46

N



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 47

47



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

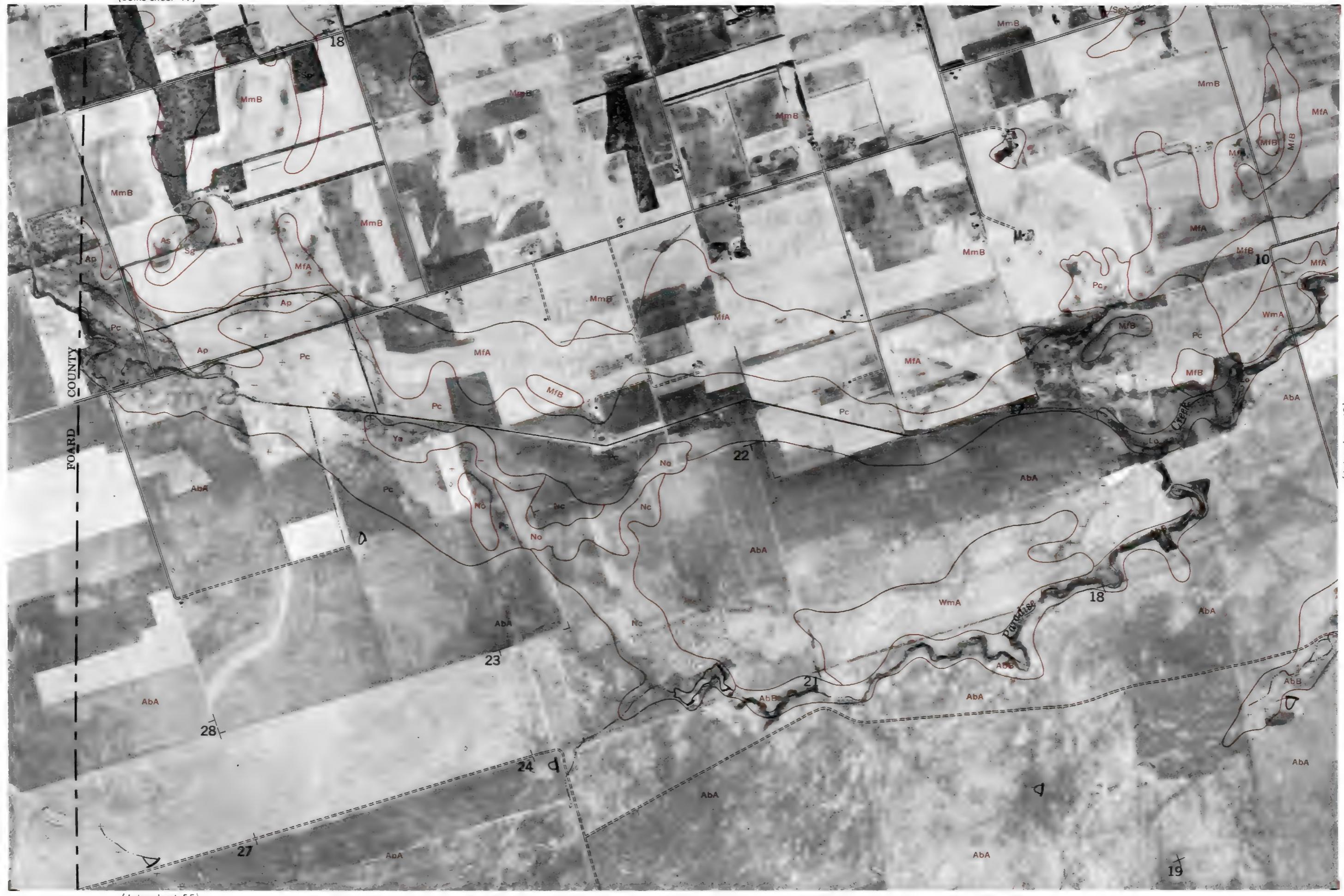
Land division corners and numbers shown on this map are indefinite.

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 48

48

N  
↑

(Joins sheet 41)



(Joins sheet 49)

(Joins sheet 55)

0

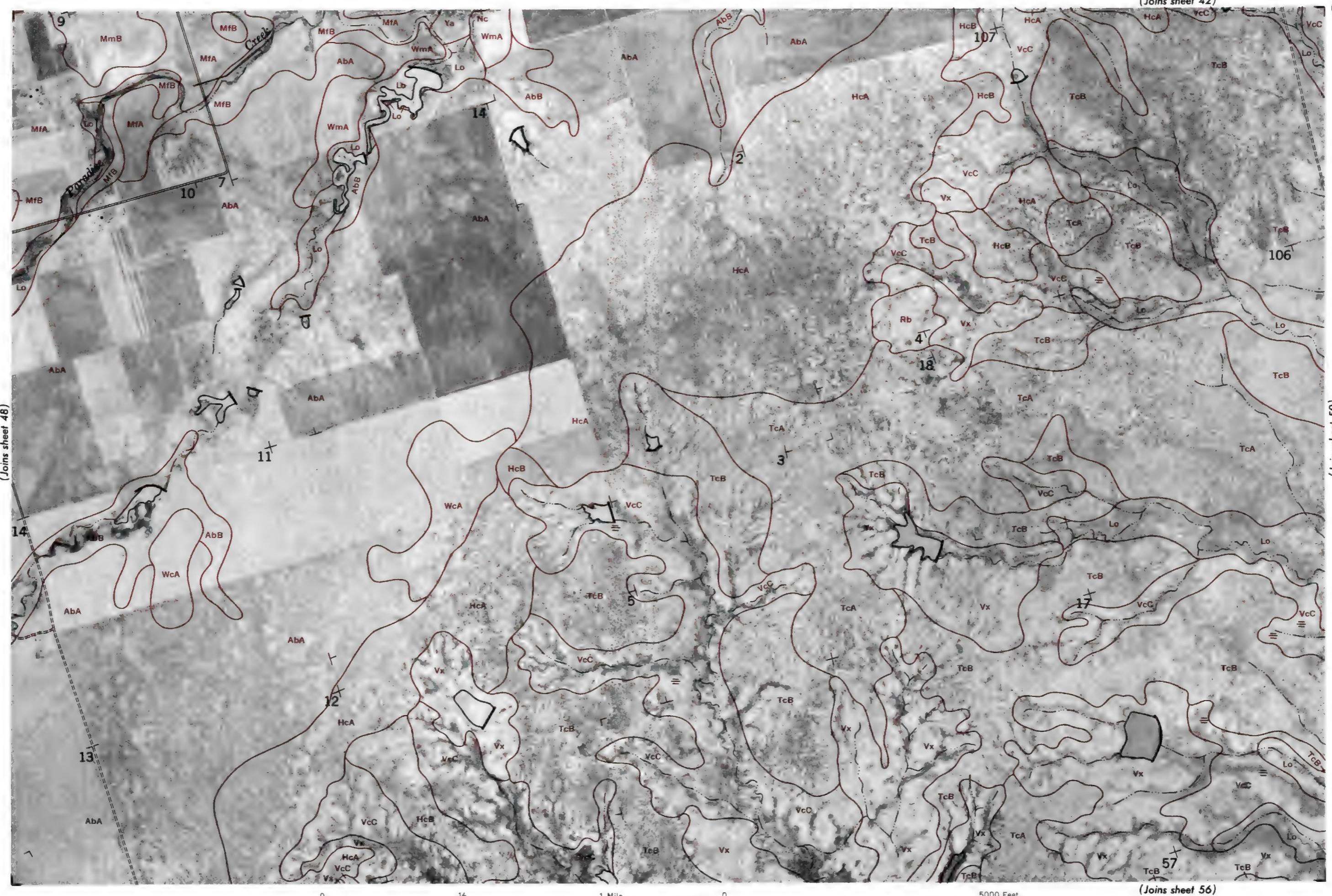
½

1 Mile

Scale 1:20 000

0  
5000 Feet

WILBARGER COUNTY, TEXAS - SHEET NUMBER 49



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

Land division corners and numbers shown on this map are indefinite.





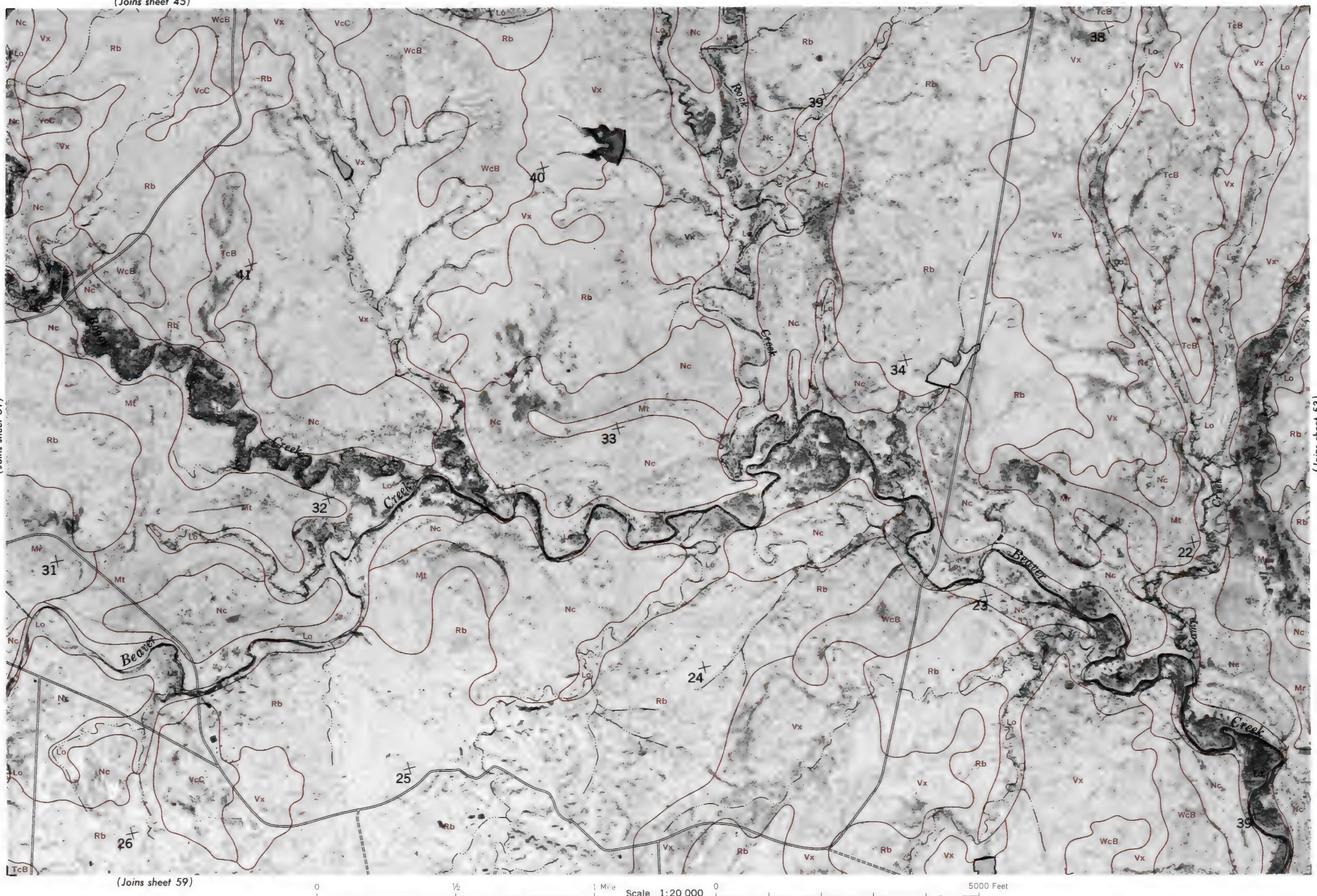
WILBARGER COUNTY, TEXAS - SHEET NUMBER 5

52

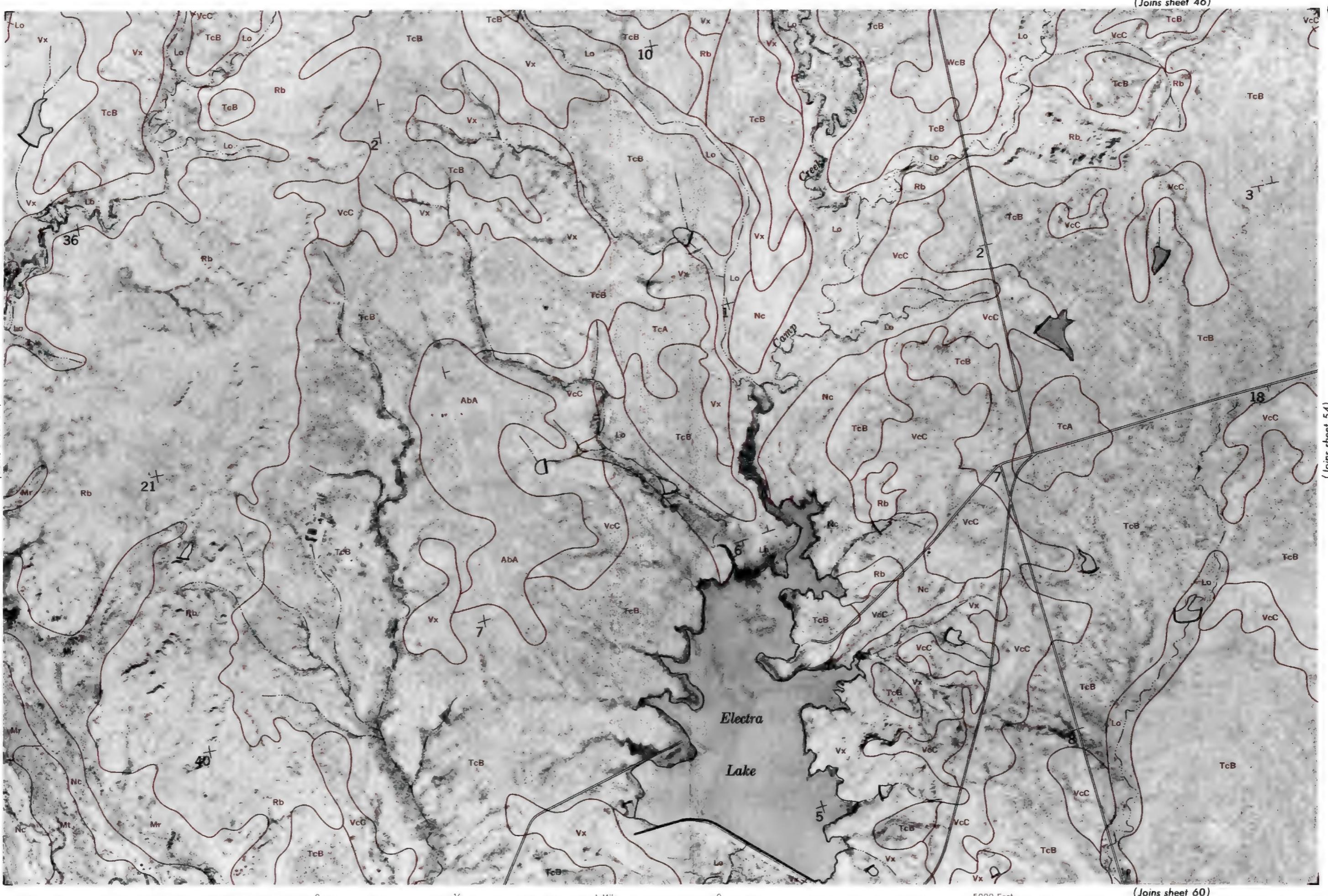
4

(Joins sheet 57)

(Joins sheet 45)



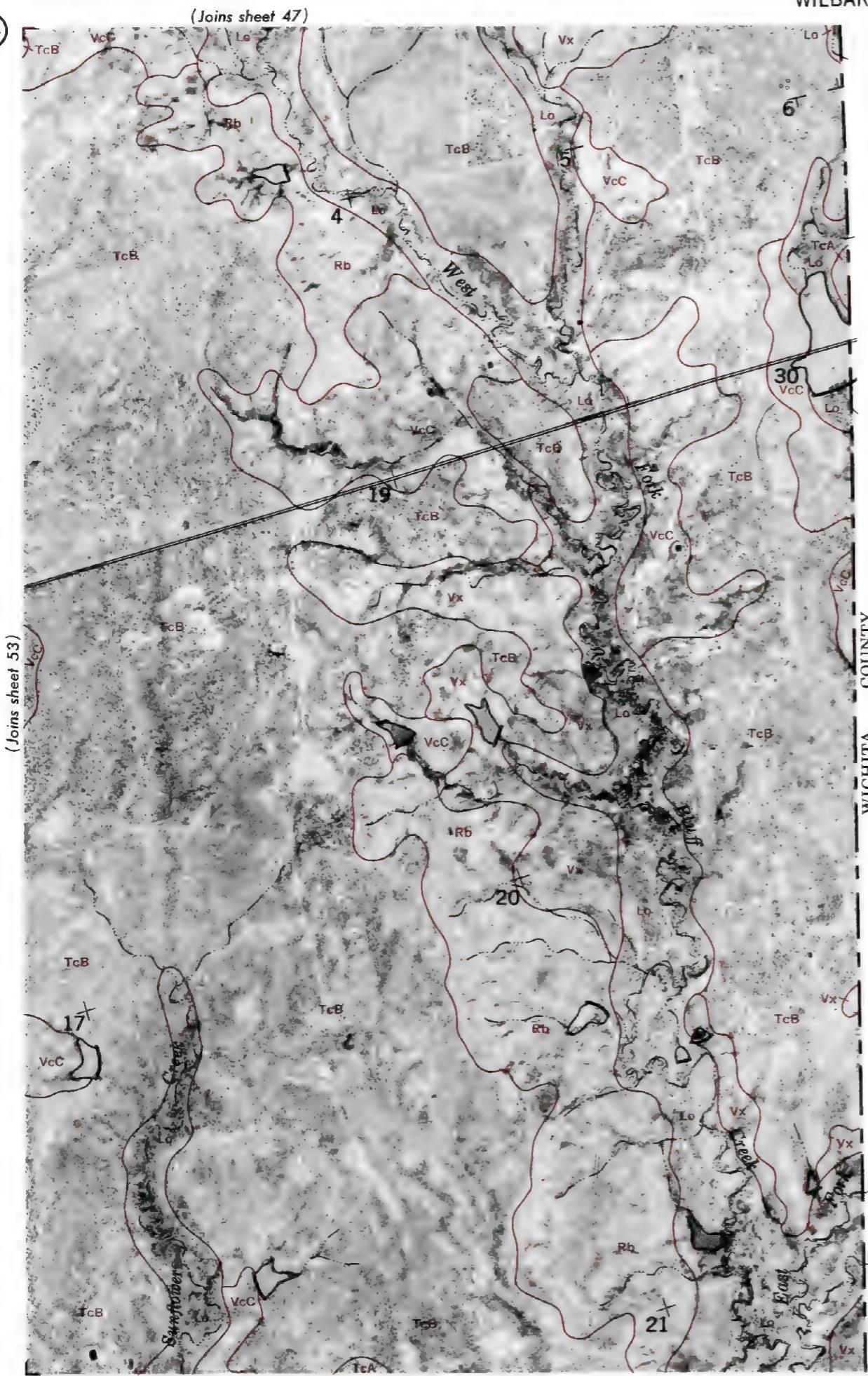
## WILBARGER COUNTY, TEXAS - SHEET NUMBER 53



WILBARGER COUNTY, TEXAS - SHEET NUMBER 54

54

N



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 55

(Joins sheet 48)

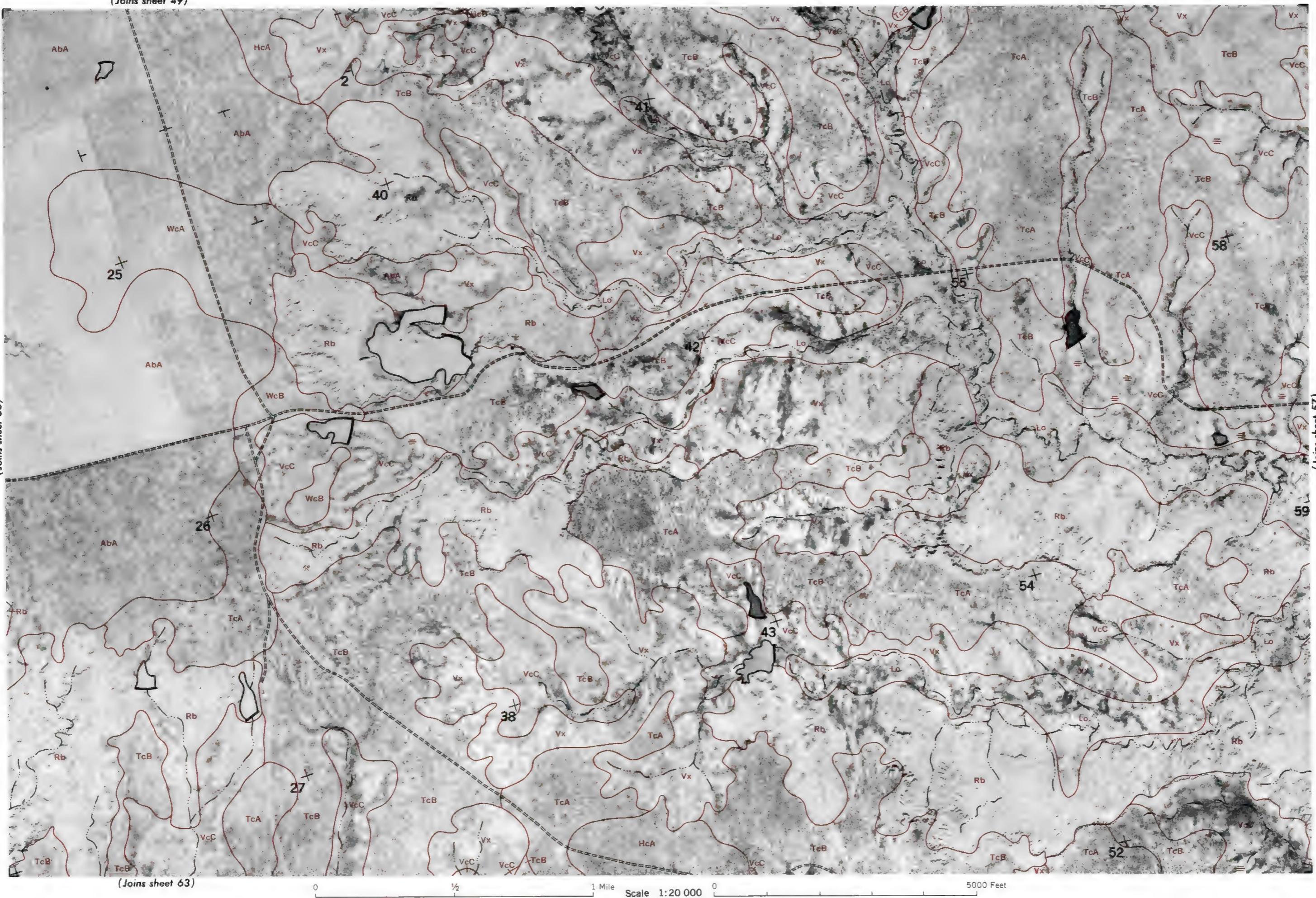
55



0 1/2 1 Mile 0 5000 Feet

(Joins sheet 49)

N

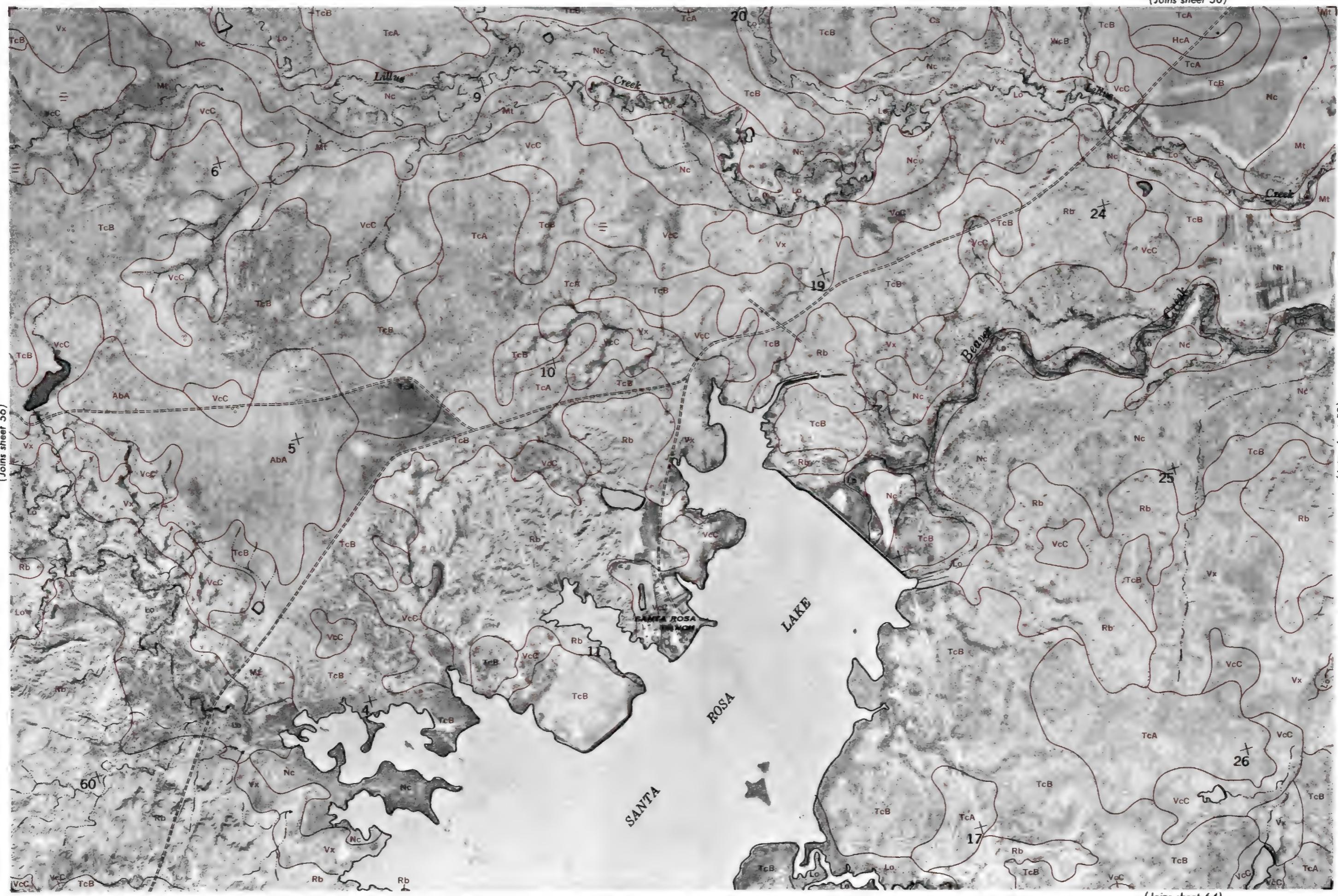


WILBARGER COUNTY, TEXAS - SHEET NUMBER 57

(Joins sheet 50)

57

N

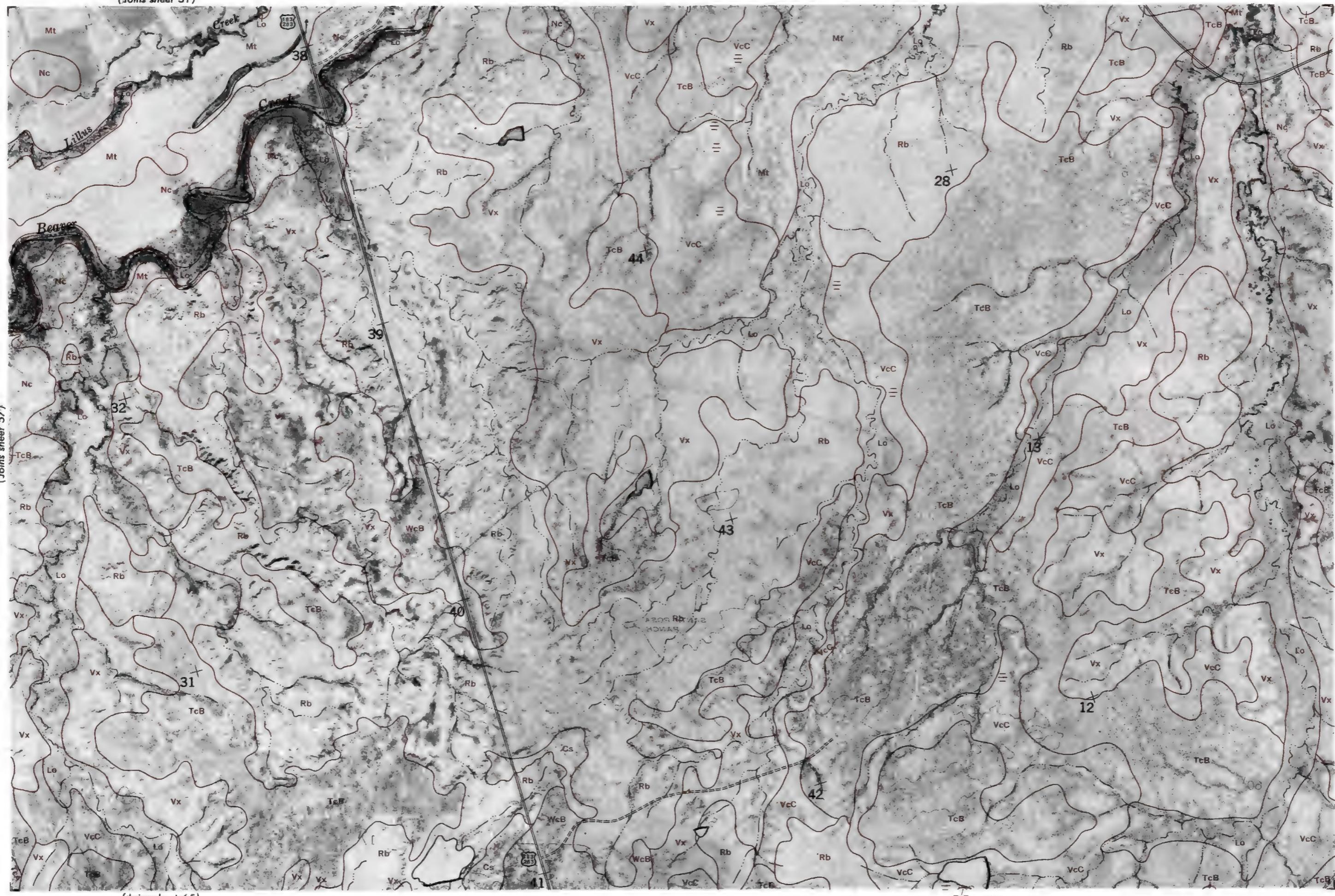


WILBARGER COUNTY, TEXAS - SHEET NUMBER 58

(Joins sheet 57)

58

N



(Joins sheet 65)

0 1/2 1 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 59)

**WILBARGER COUNTY, TEXAS - SHEET NUMBER 59**

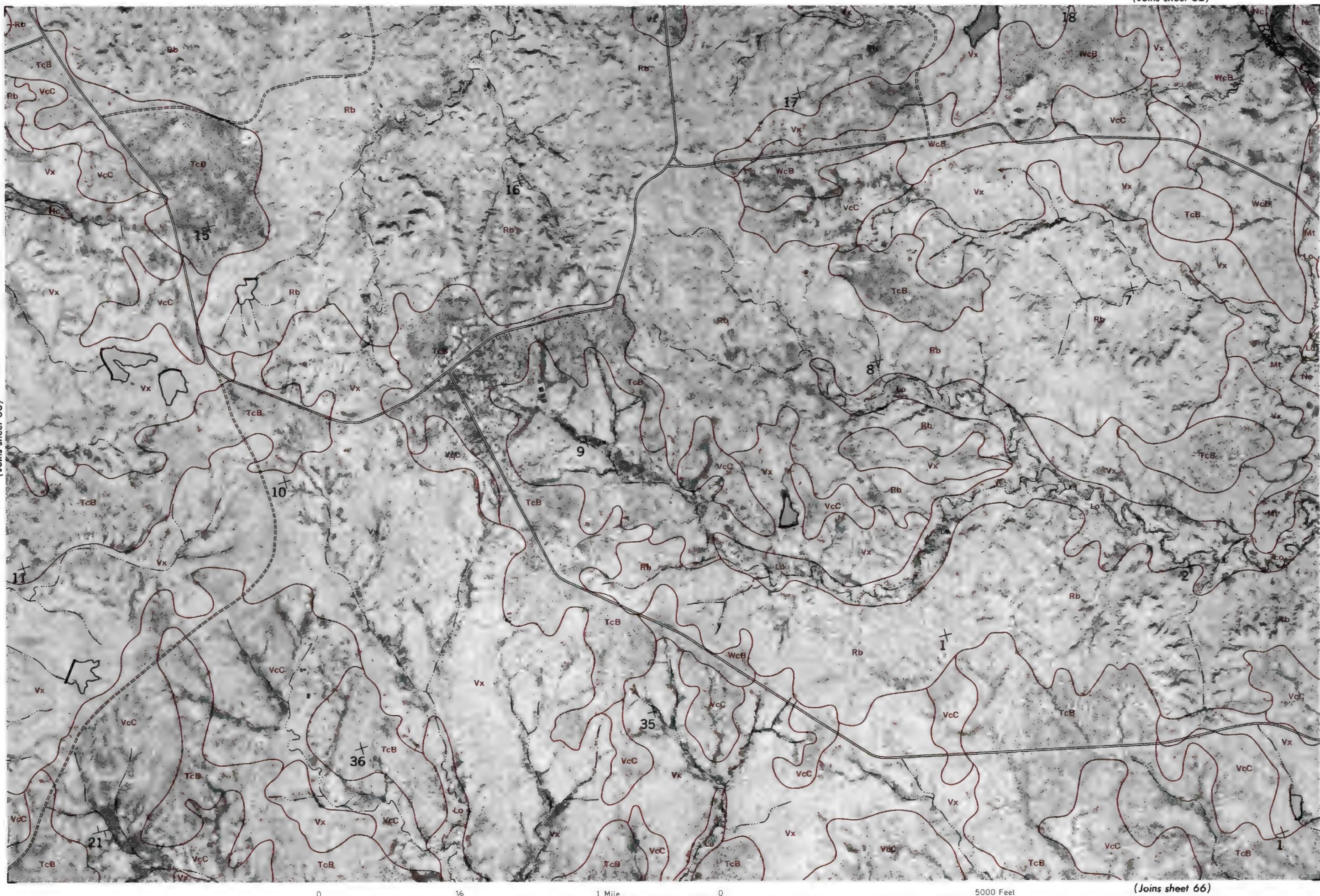
(Joins sheet 52)

59

Join sheet 60)

(Joins sheet 66)

regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

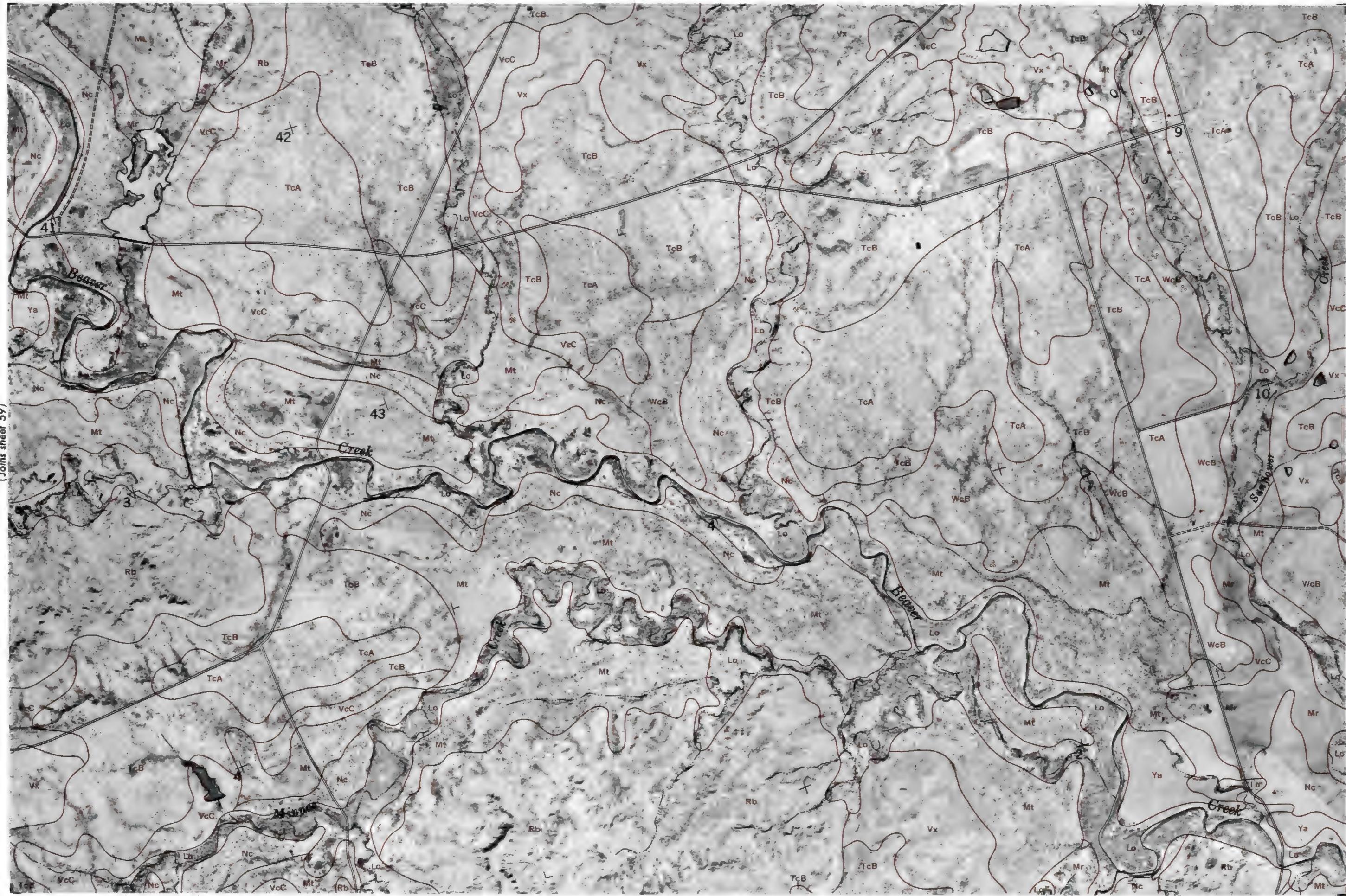


(Joins sheet 53)

WILBARGER COUNTY, TEXAS - SHEET NUMBER 60

60

N  
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(Joins sheet 67)

0

1/2

1 Mile

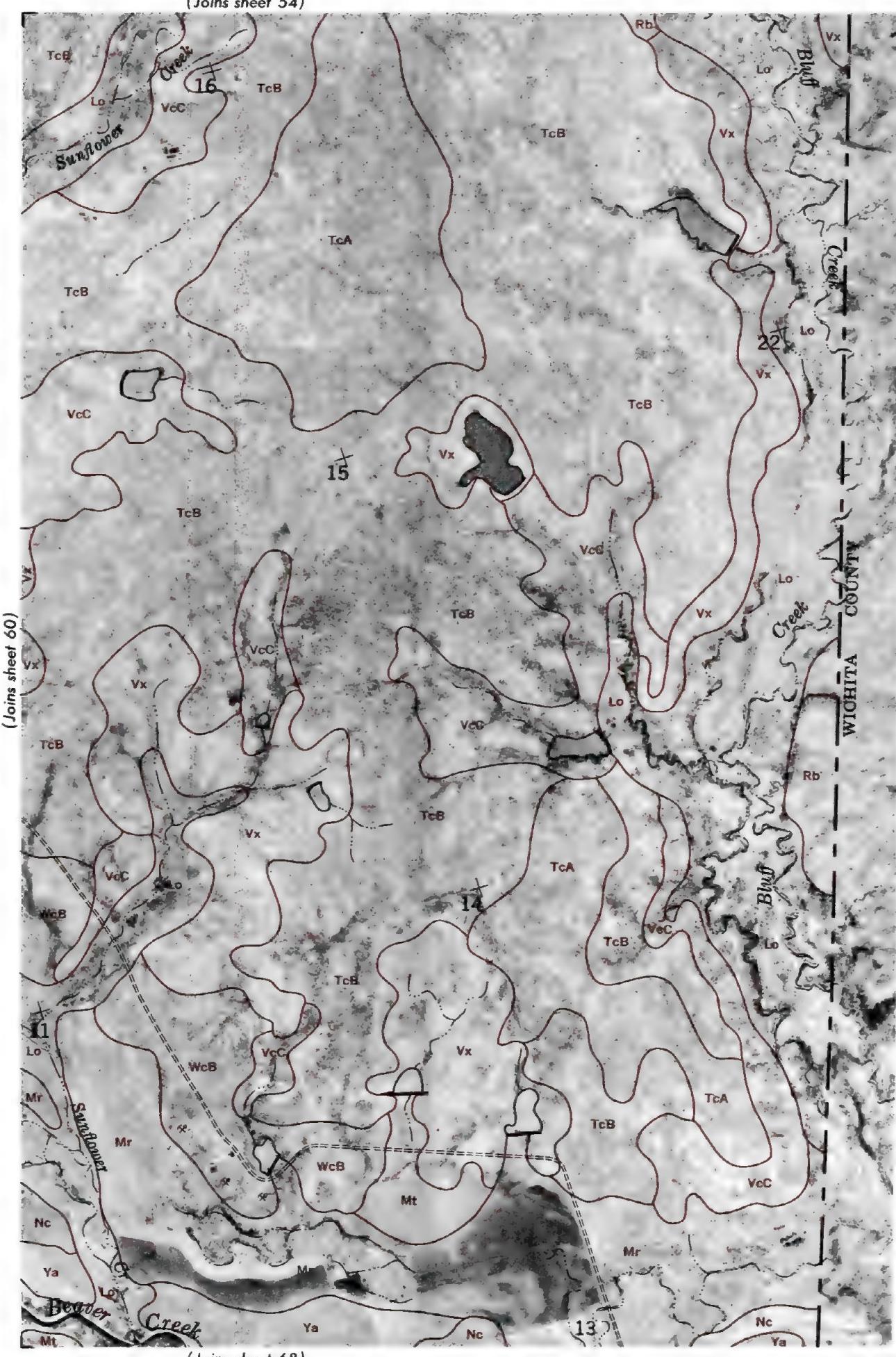
Scale 1:20 000

0

5000 Feet

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 61

61



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

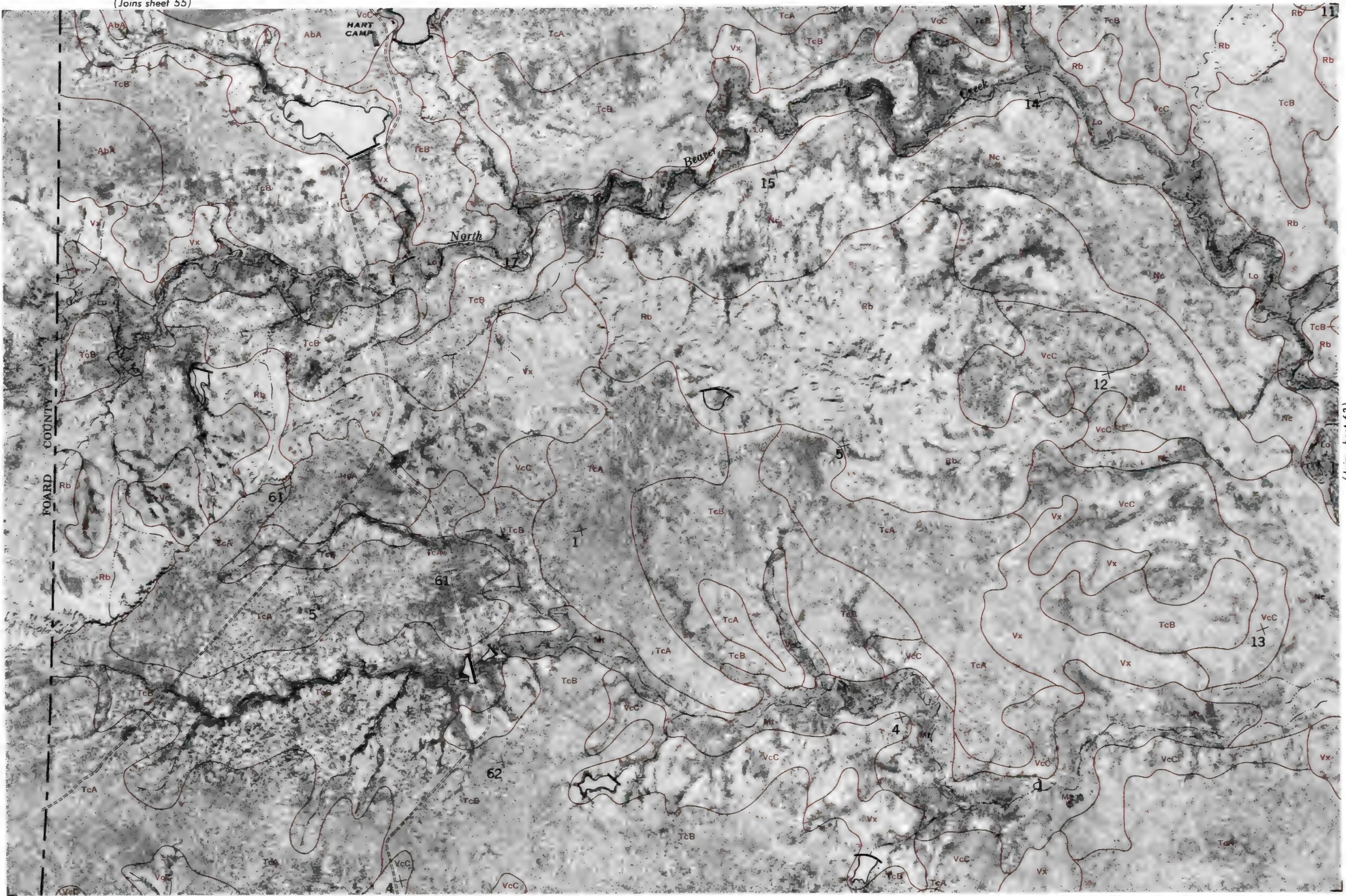
Land division corners and numbers shown on this map are indefinite.

WILBARGER COUNTY, TEXAS - SHEET NUMBER 62

62

N  
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(Joins sheet 55)



(Joins sheet 63)

(Joins sheet 69)

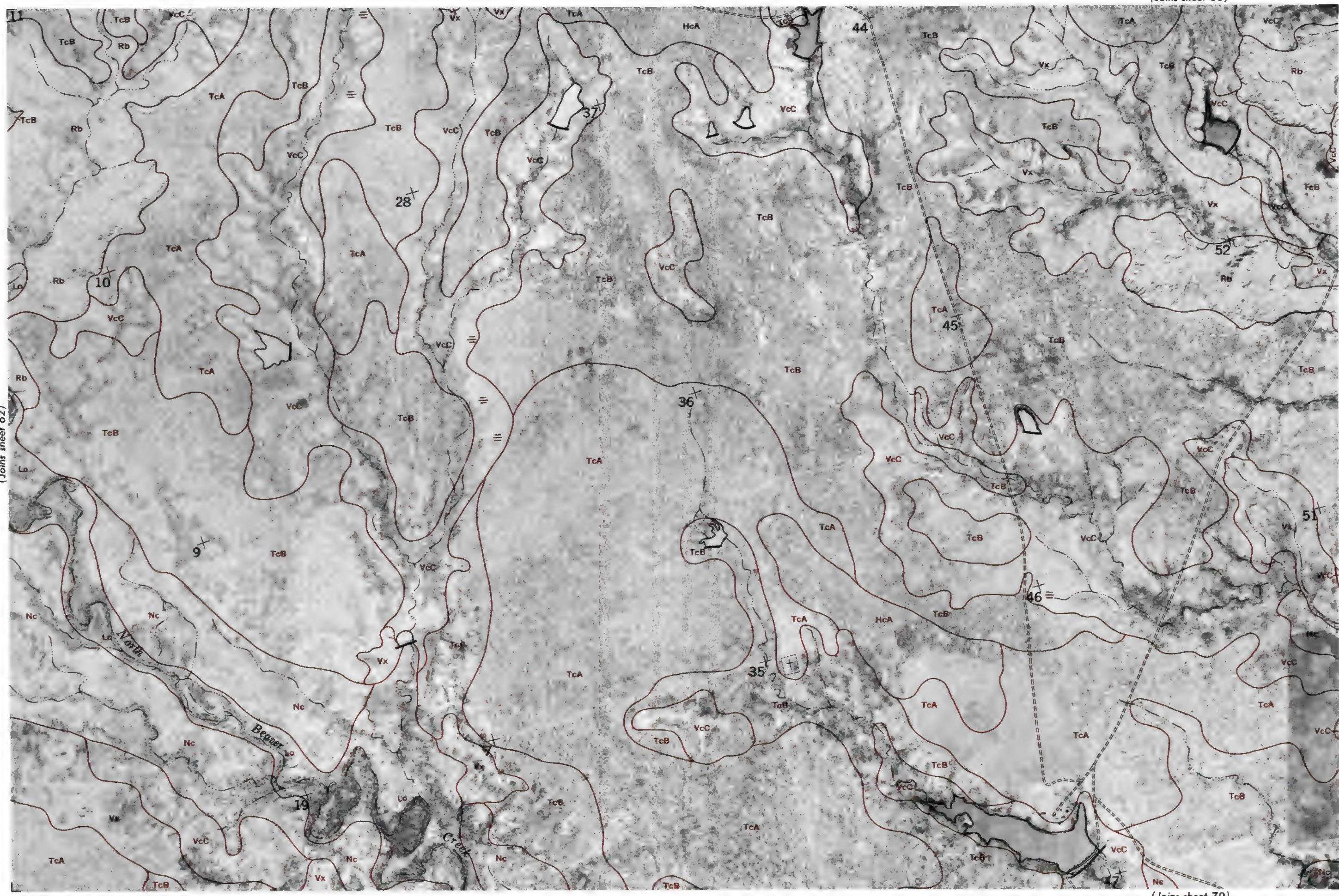
0 1/2 1 Mile 0 1 1 1 5000 Feet

Scale 1:20 000

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 63

(Joins sheet 56)

63



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 64

(Joins sheet 57)

64

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(Joins sheet 63)

(Joins sheet 65)

(Joins sheet 71)

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1 M.e.

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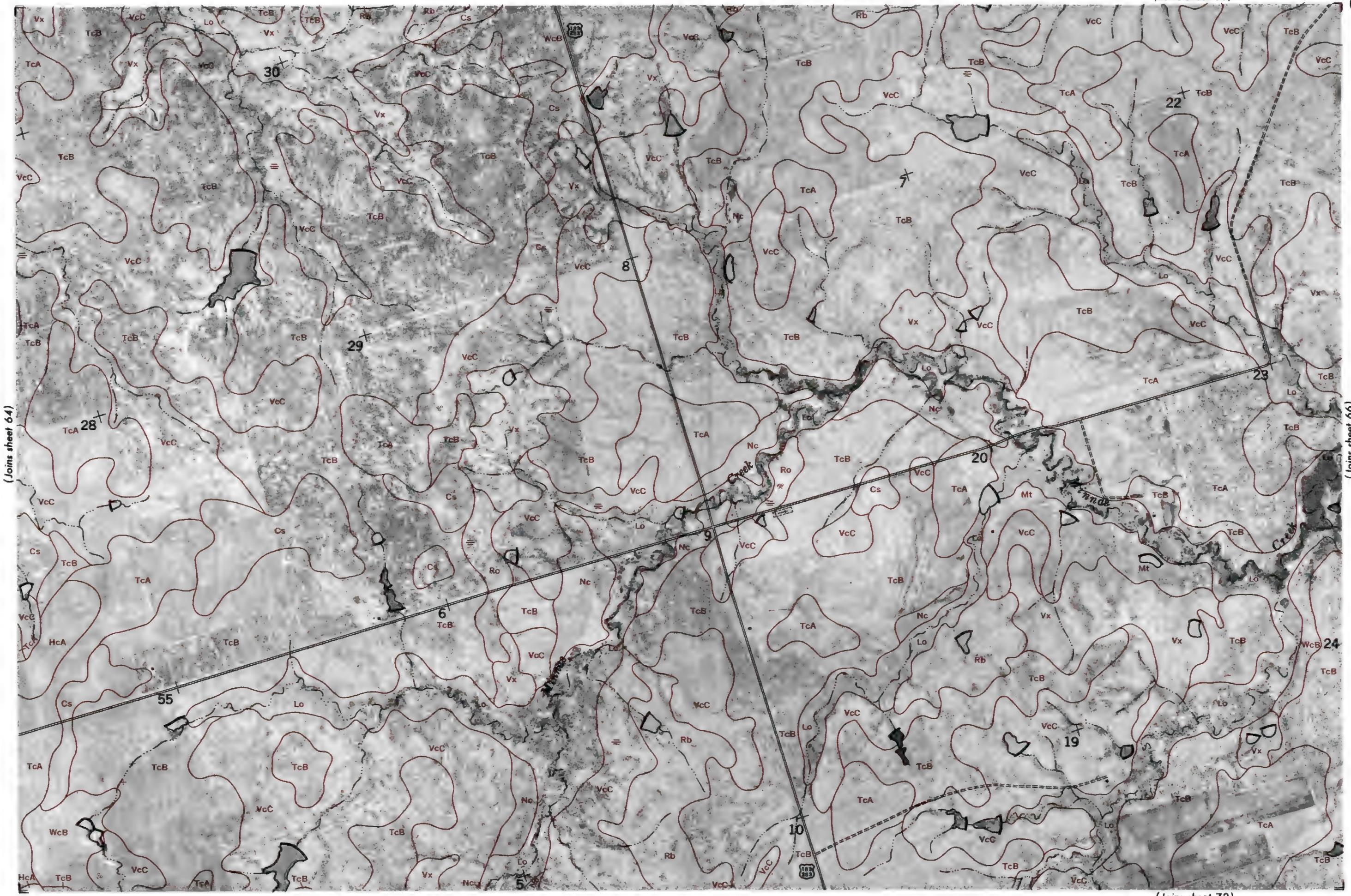
5000 Feet

Scale 1:20 000

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 65

(Joins sheet 58)

65

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WILBARGER COUNTY, TEXAS - SHEET NUMBER 66

(Joins sheet 59)

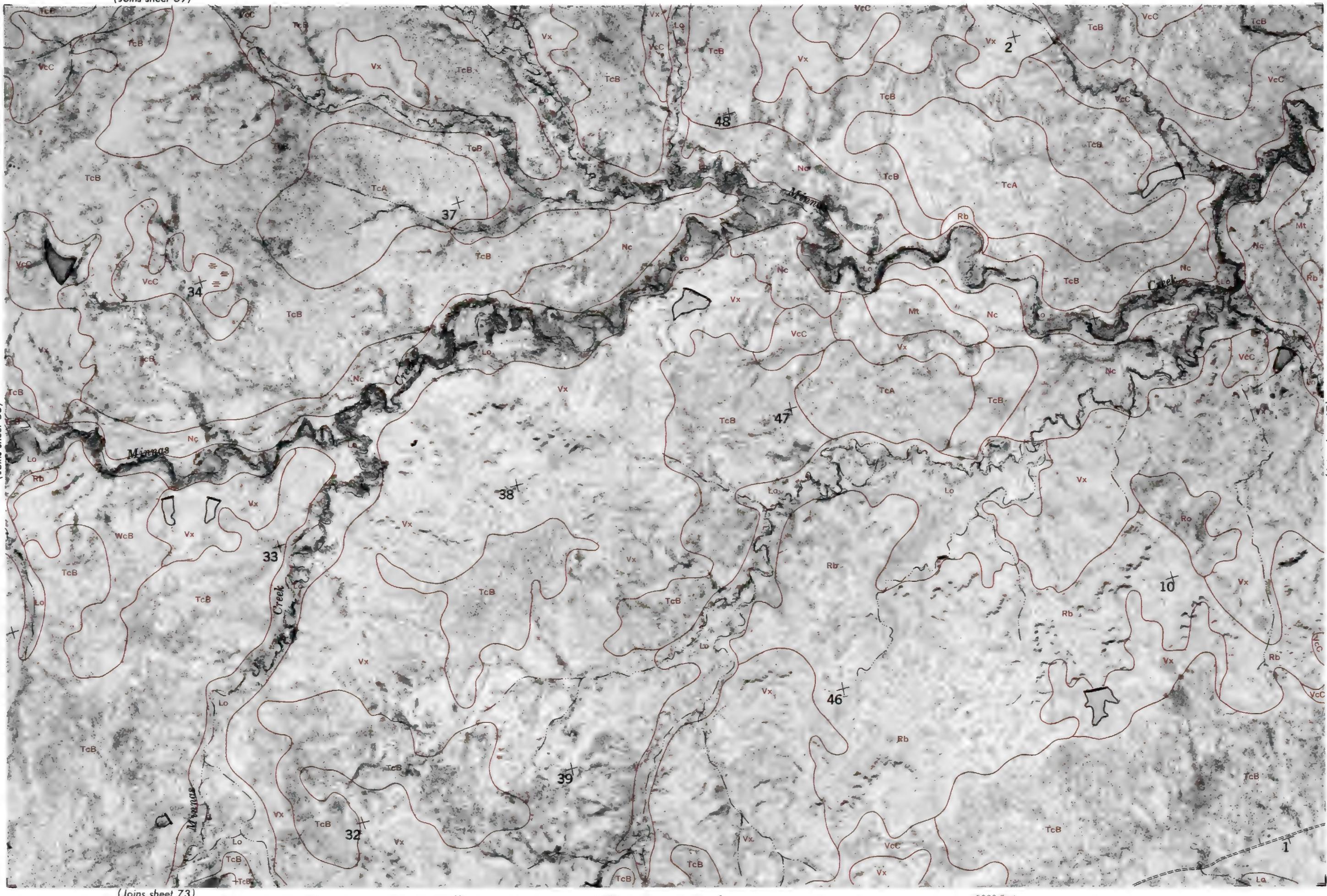
66

N



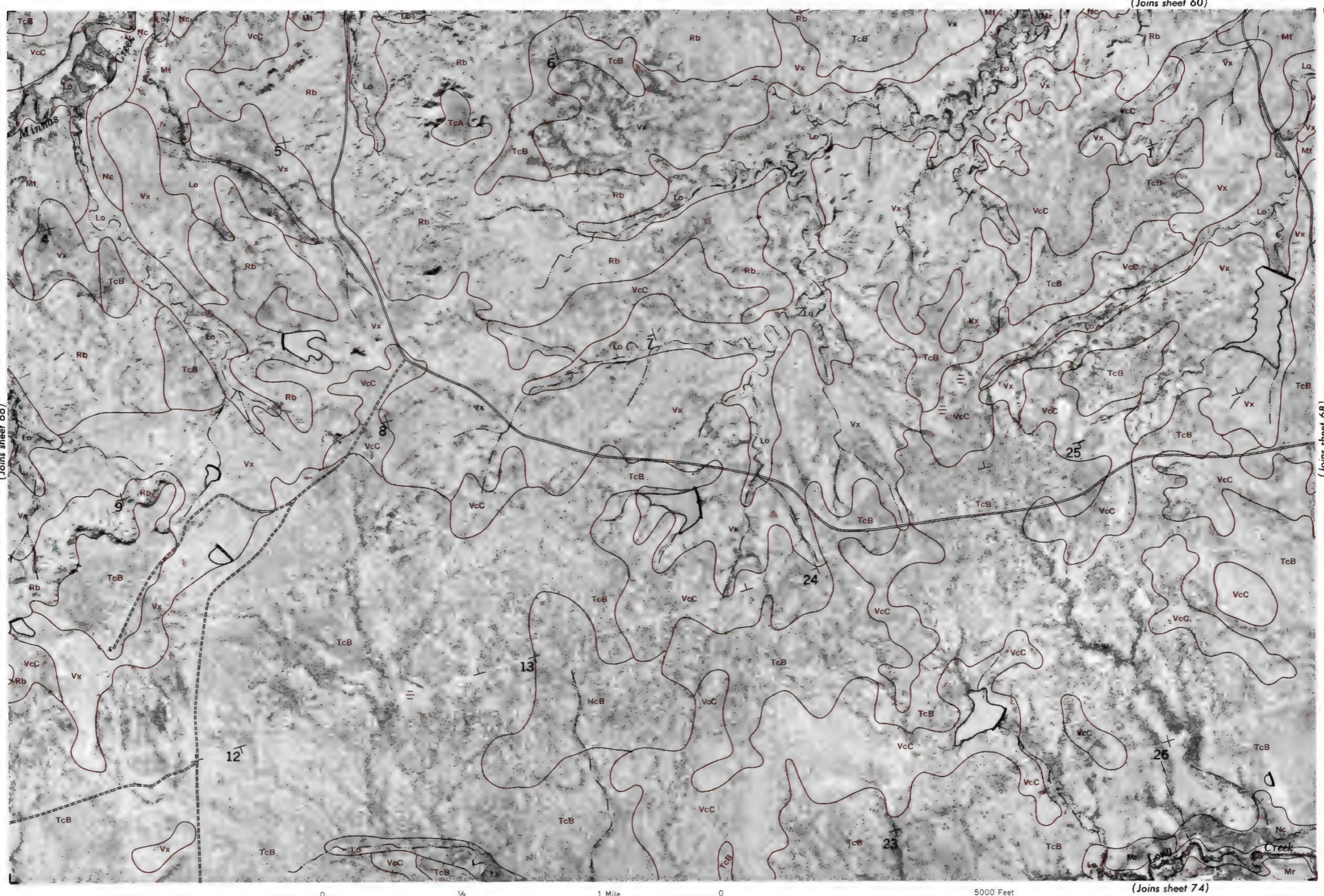
(Joins sheet 65)

(Joins sheet 67)



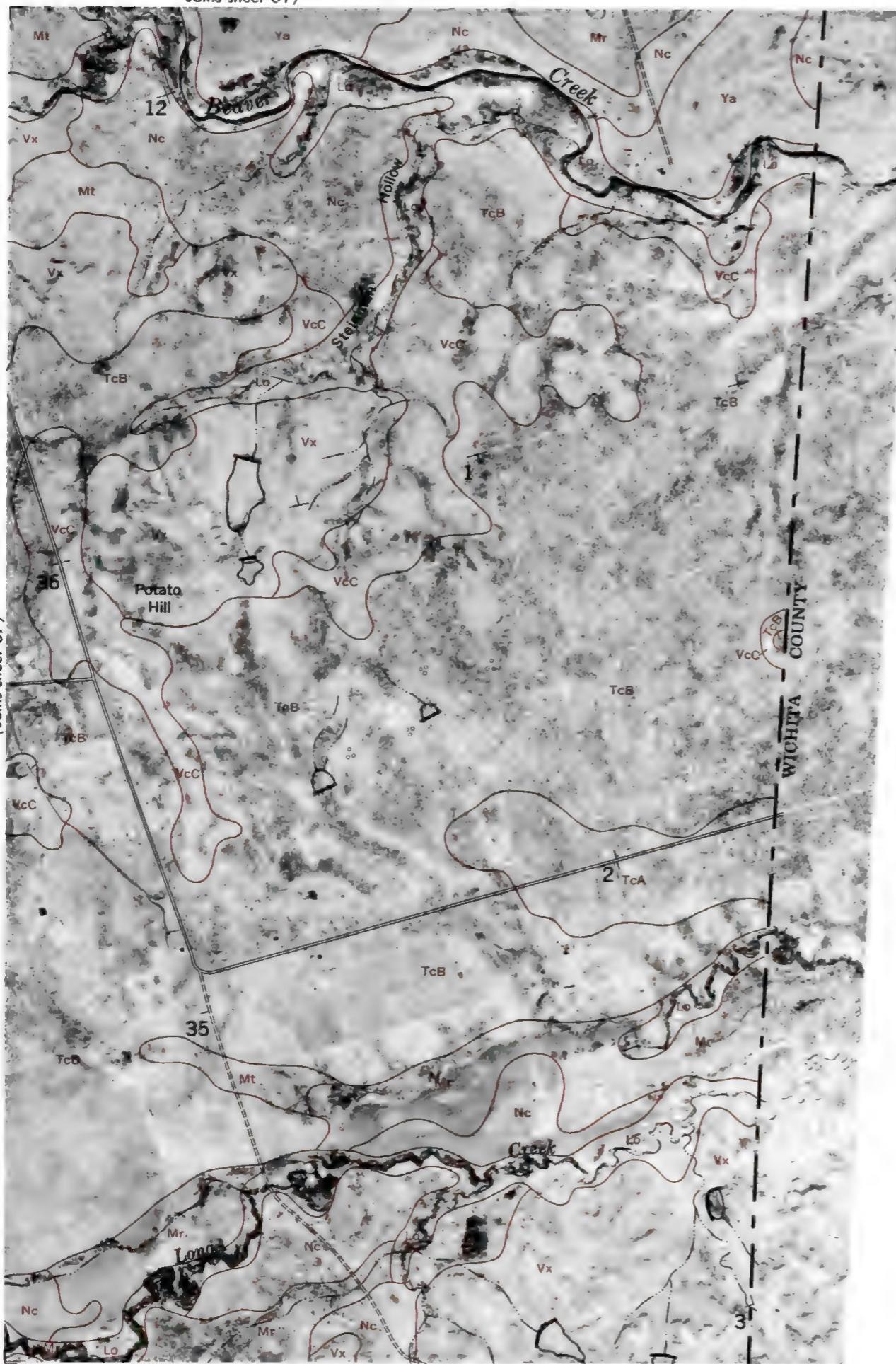
(Joins sheet 73)

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 67



68

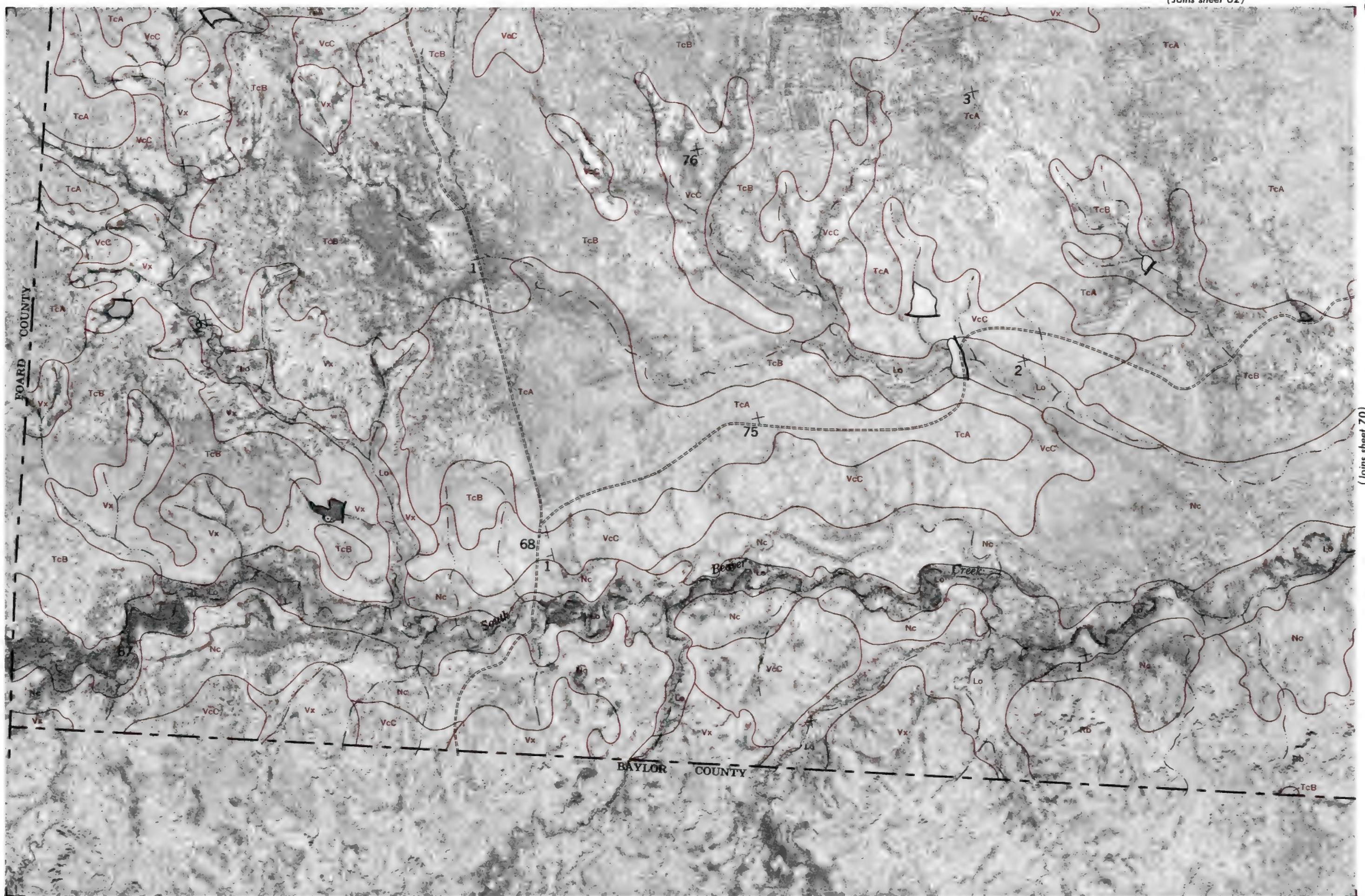
## WILBARGER COUNTY, TEXAS - SHEET NUMBER 68

N  
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## WILBARGER COUNTY, TEXAS - SHEET NUMBER 69

(Joins sheet 62)

69



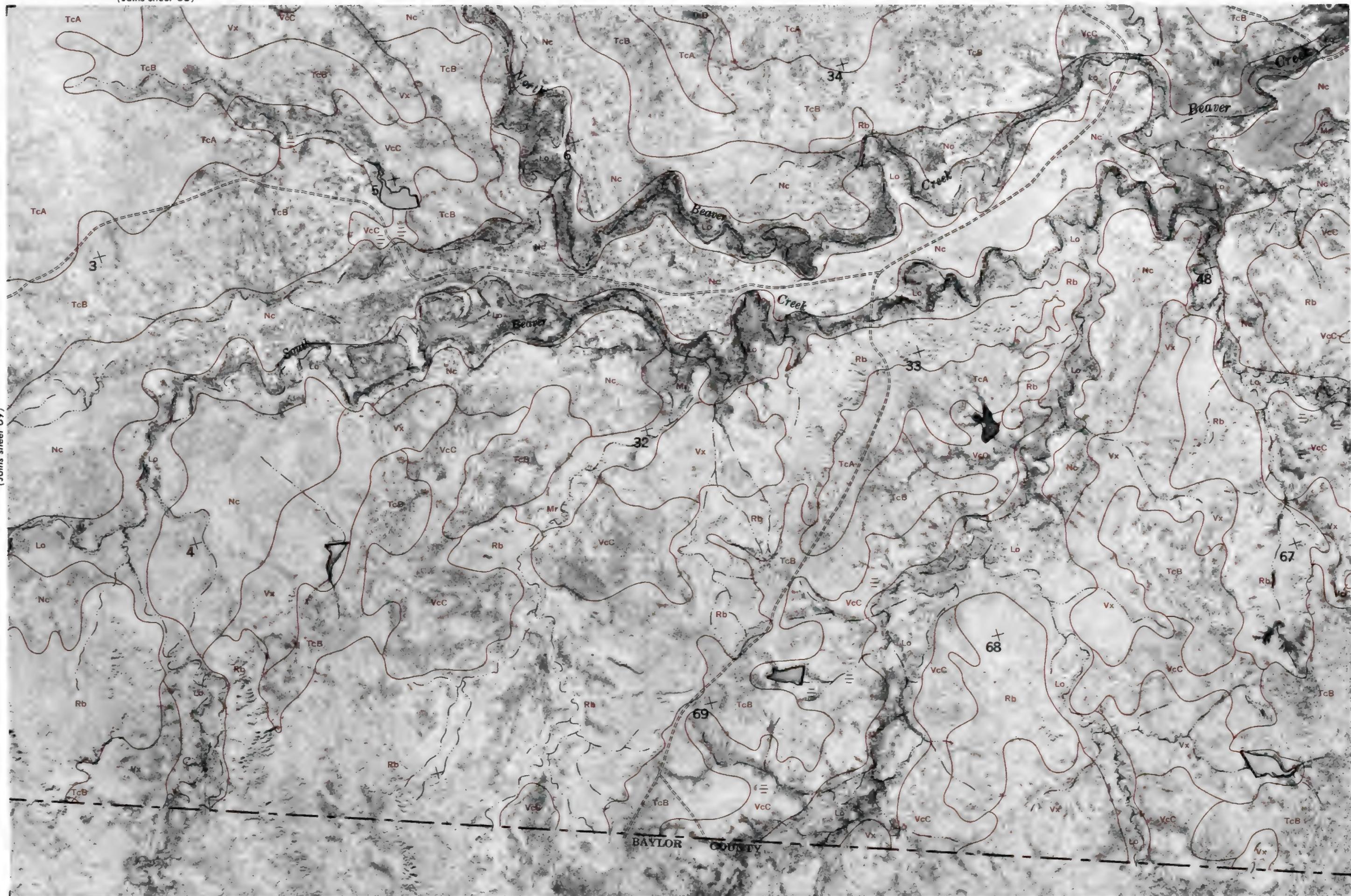
N

WILBARGER COUNTY, TEXAS - SHEET NUMBER 70

(70)

N  
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(Joins sheet 63)



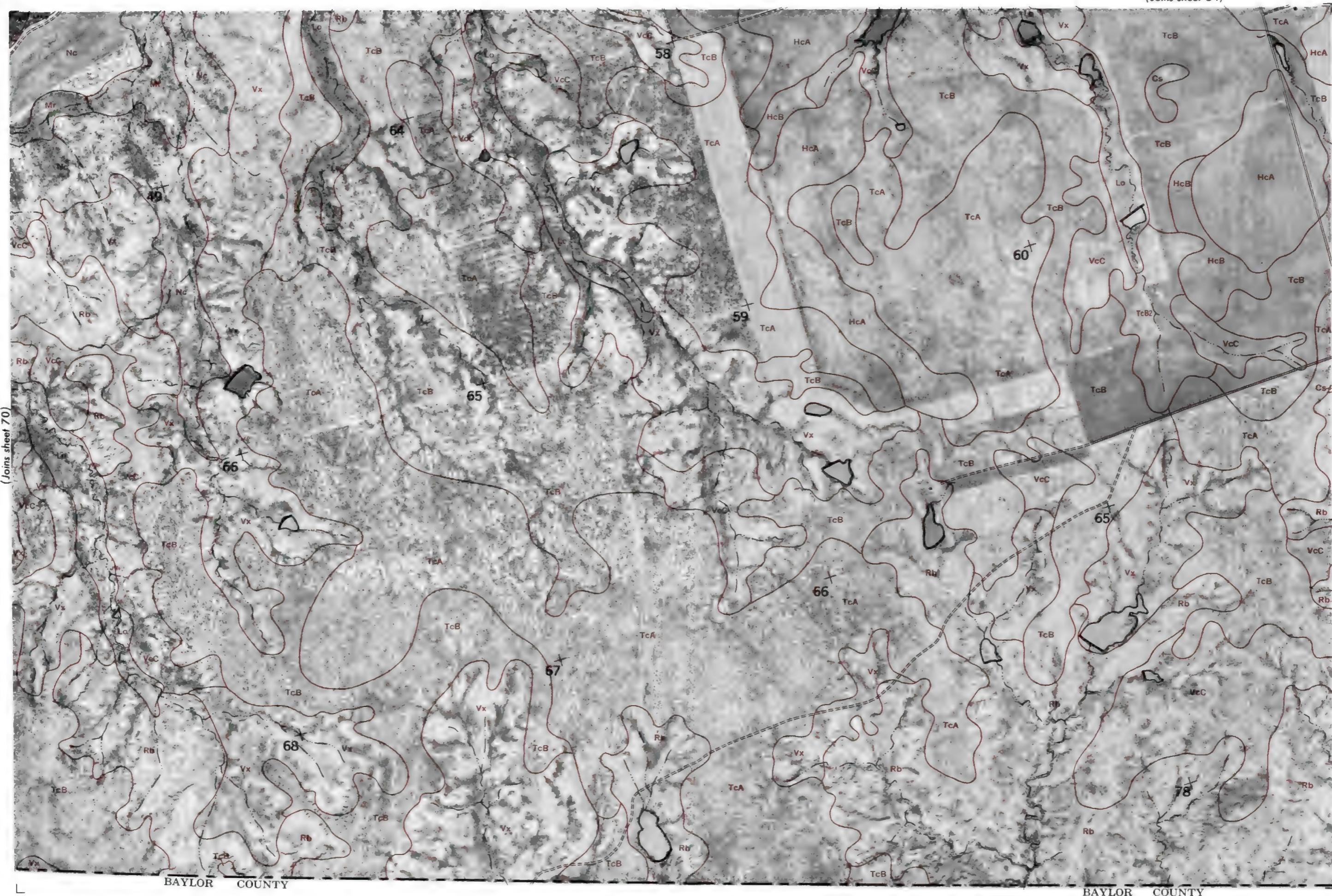
(Joins sheet 69)

(Joins sheet 71)

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 71

(Joins sheet 64)

71



(Joins sheet 70)

(Joins sheet 72)

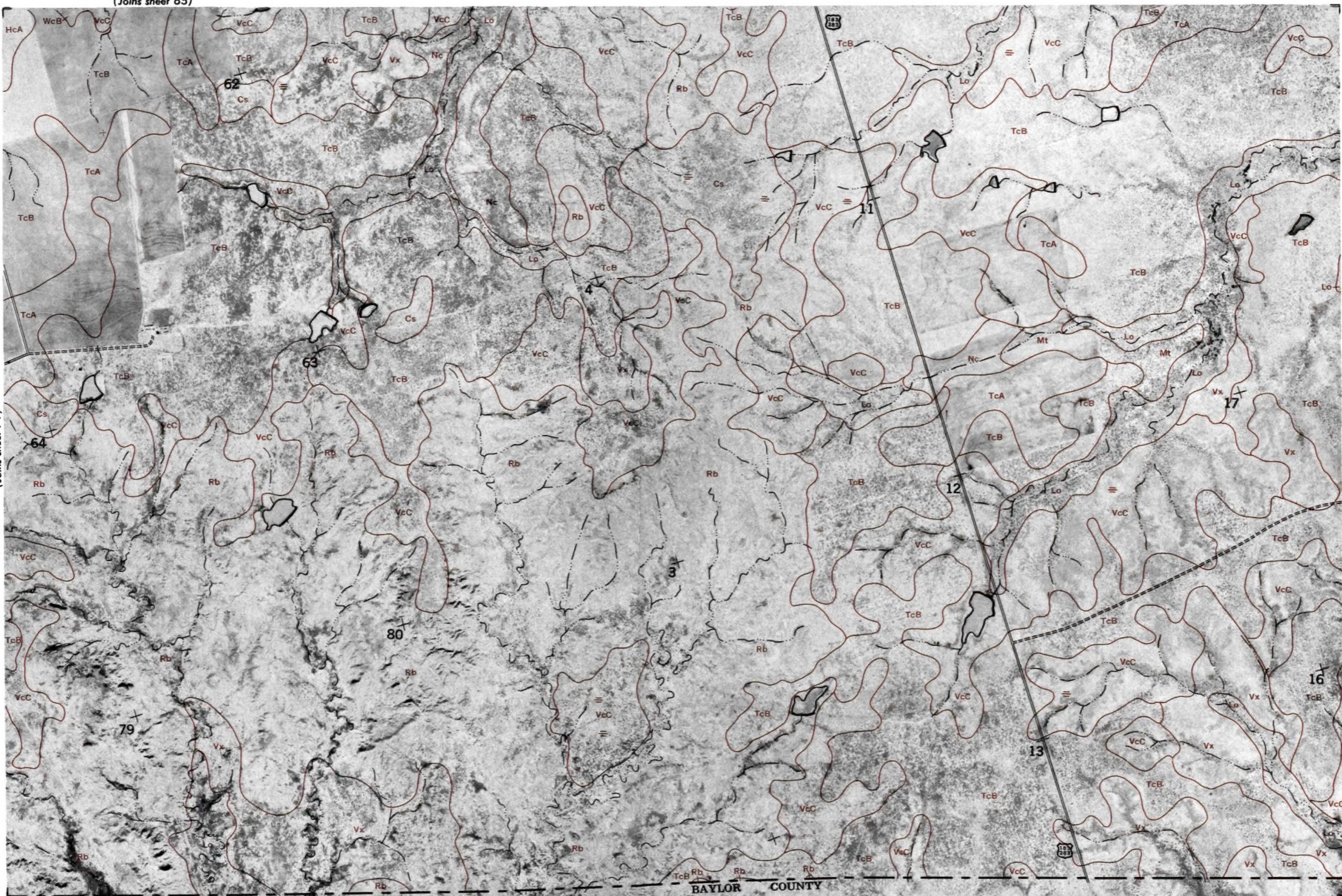
72

(Joins sheet 65)

N

(Joins sheet 71)

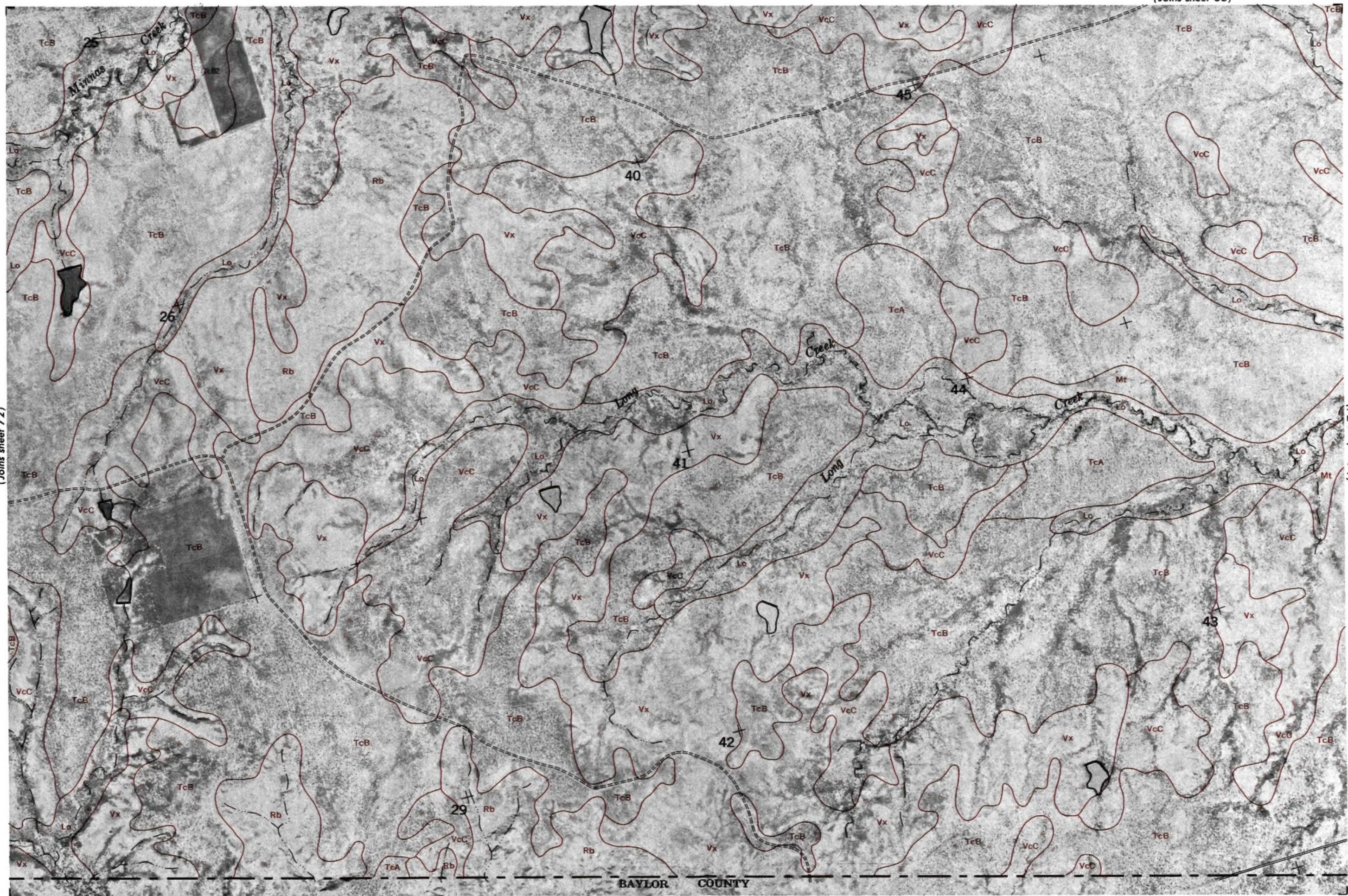
Line sheet 731



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 73

(Joins sheet 66)

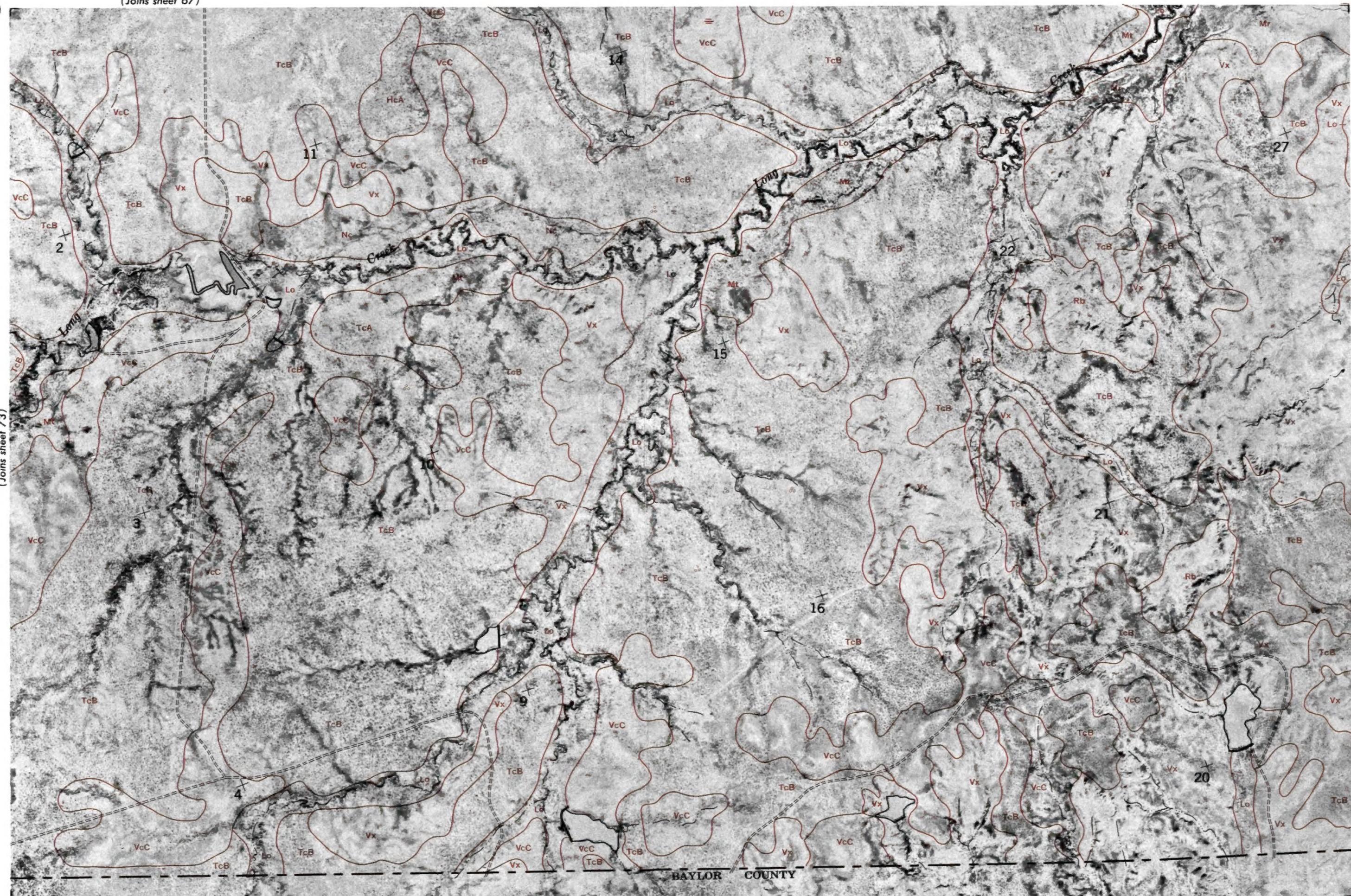
73



## WILBARGER COUNTY, TEXAS - SHEET NUMBER 74

(Joins sheet 67)

74

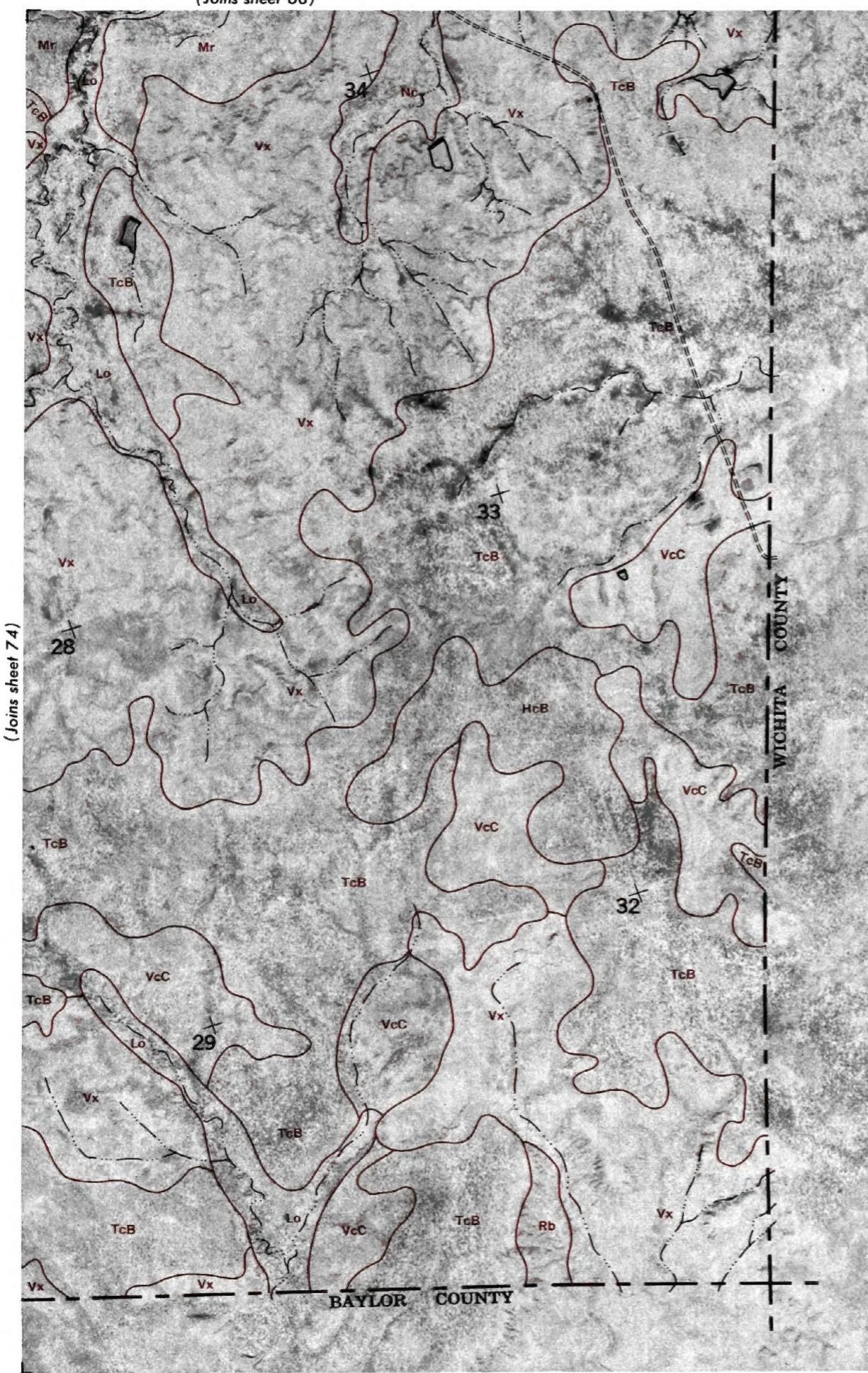


(Joins sheet 73)

(Joins sheet 75)

## WILBARGER COUNTY, TEXAS - SHEET NUMBER 75

75



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.  
Land division corners and numbers shown on this map are indefinite.

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet